DOCUMENT RESUME

ED 349 740 EC 301 485

AUTHOR	Boone, Randall, Ed.; Higgins, Kyle, Ed.
TITLE	Multimedia. TAM Topical Guide #1.
INSTITUTION	Council for Exceptional Children, Reston, VA. Technology and Media Div.
PUB DATE	92
NOTE	95p.
AVAILABLE FROM	Department of Exceptional Education, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53217 ($12.50, quantity discount available for 15 or more, make check payable to TAM Multimedia Guide).
PUB TYPE	Collected Works - General (020) -- Guides - Non-Classroom Use (055)
EDRS PRICE	MF01/PC04 Plus Postage.
DESCRIPTORS	Administrator Attitudes; Authoring Aids (Programing); Basal Reading; Classroom Techniques; *Computer Assisted Instruction; Creative Thinking; Critical Thinking; *Disabilities; Educational Media; Educational Technology; Elementary Secondary Education; Encyclopedias; *Hypermedia; Information Systems; Instructional Design; Interactive Video; *Learning Laboratories; *Multimedia Instruction; Reading Instruction; Teacher Education; *Teaching Methods; Units of Study

ABSTRACT

Educational multimedia and hypermedia systems, which integrate computer-generated text and graphics with full-motion video and stereo sound, dominate much discussion about the future of computer use in education. This guide brings together the thoughts, ideas, and experience of elementary school students, classroom teachers, administrators, university-based teacher educators, and educational researchers who have several years of experience with multimedia/hypermedia hardware and software. The guide's eight articles attempt to provide a composite profile of what can be expected from the technology and what the technology requires from those who want to use it, particularly with special needs students. The guide addresses instructional design of multimedia/hypermedia materials, classroom management, teacher and student training, equipment acquisition, student perceptions, teacher perceptions, and administrative perspectives. Articles include: "Teacher Training in Multimedia: Content Enhancements and Considerations for Instruction" (Cheryl Wissick); "Envisioning, Acquiring, and Running a Multimedia Lab in Your Classroom" (Karen Perlbachs); "Building a Hypermedia Classroom Unit" (Susan McGrath); "Using a Hypermedia Encyclopedia with Third Graders" (Marilyn Heyn); "Enhancing Critical and Creative Thinking with a Multimedia Authoring Tool" (Louise Wilson); "A Principal's View of Hypermedia" (Vera Risdon); "The Multimedia Classroom" (Elaine Montoya Prickett); and "Hypermedia Enhanced Basal Readers: 'A Book Can't Do That...'" (Randall Boone and Kyle Higgins). A resources section lists definitions of terms; books, directories, and newsletters; publishers of multimedia software, videodiscs, and other educational technology; and 33 references. (JDD)

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Multimedia

TAM Topical Guide # 1

Randall Boone
Kyle Higgins

Editors

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Published by the Technology and Media Division
The Council for Exceptional Children
1920 Association Drive
Reston, VA 22091-1589

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Introduction

By Randall Boone and Kyle Higgins

Educational multimedia and hypermedia systems are exceedingly popular at the present time. These computer-based information presentation systems dominate much of the current discussion about the future of computer use in education. A review of the *Proceedings of the 1991 National Educational Computing Conference* indicates that more than 50 workshops or sessions were presented that specifically addressed educational multimedia or hypermedia. By comparison, the 1988 conference had only five. In the three short years between these two conferences a new and exciting form for computer-based instruction developed. It is more an aggregate of existing technologies, however, than anything really new in itself.

A microcomputer acts as both the controller and as one of the participating mediums in a multimedia / hypermedia system. Computer-generated text and graphics are integrated with full-motion video and stereo sound through hardware connection to videodisc and videotape players, CD-ROM drives, MIDI music input devices or instruments, voice recognition systems, and speech generation hardware and software. The information choreography necessary for providing quick and sometimes simultaneous access to all the data in these interconnected media is usually constructed in a non-linear format using software programs such as HyperCard (Atkinson, 1987) for the Macintosh, Linkway (Kheriaty, 1989) for IBM compatibles, and HyperStudio (O'Keefe, 1989) for the Apple GS.

New Terms and Similar Definitions

Although hypermedia and multimedia are relatively new terms for today's computer-using educators, the basic concept of non-sequential, computer-based information retrieval first was envisioned more than 40 years ago (Bush, 1945). With such interest in hypermedia and multimedia growing rapidly throughout the educational community since these capabilities for microcomputers became widely available in 1986, some new terms and definitions need to be examined. Hypertext, hypermedia, multimedia, and integrated media are all terms for overlapping concepts.

Hypertext. The term hypertext refers to computer-based texts that are read in a non-linear fashion and that are organized on

multiple dimensions (Spiro and Jehng, 1990).

Hypermedia. Hypermedia (is) a hypertext document that includes graphics, digitized speech, music, or video segments (Boone and Higgins, 1991).

Multimedia. Educational interactive multimedia (is) non-sequential and non-linear presentation of text, graphics, animation, voice, music, movies, or motion video in a unified information-delivery system centered on a personal computer, that involves the student as an active participant and is applied in an educational setting for any number of instructional purposes (Center for Special Education Technology, 1991).

Integrated media. The linkage of text, sound, video, graphics, and the computer in such a way that the user's access to these various media is non-linear and virtually instantaneous (Hasselbring, Goin, & Bransford, 1991).

This new format for information access and display that is described collectively by the above definitions, as it evolves through classroom use and educational research, will surely take on many different forms and employ vastly different instructional designs. Some of these products will offer electronic data bases for exploration such as the electronic encyclopedias and other reference works now available on CD-ROM. Many will take existing textbooks or literature and enhance them for different purposes with the technology. Others will create new microworlds for exploratory learning and building problem-solving skills. Some may incorporate all of these ideas. The possibilities are many.

Should we expect students to learn more, better, and faster by using these new hypermedia and multimedia systems? Will these systems make it easy for teachers to use and integrate computers in their classrooms? Maybe. There is evidence that some students do benefit significantly from multimedia/hypermedia enhanced texts (Higgins and Boone, in press; Higgins and Boone, 1990), videodisc instruction (Hasselbring, Goin, & Bransford, 1991), and videodisc-based simulations (Wissick, 1990), but only a scant amount of empirical research has been completed to date.

This special TAM Topical Guide brings together the thoughts, ideas, and experience of elementary school students, classroom teachers, administrators, university-based teacher educators, and educational researchers all of whom have several years of experi-

ence with multimedia/hypermedia hardware and software. The eight articles that follow, it is hoped, will provide a composite profile of what can be expected from the technology and what the technology requires from those who want to use it. Instructional design of multimedia/hypermedia materials, classroom management, teacher and student training, equipment acquisition, student perceptions, teacher perceptions, and administrative perspectives are all included. A preview of the authors and their contributions in this issue follows:

Cheryl Wissick, University of South Carolina, Columbia, South Carolina.

Dr. Wissick presents a comprehensive explanation of multimedia within the tool, tutor, and tutee model (Taylor, 1980). Various uses of multimedia in education and several design issues surrounding the construction of educational multimedia are also delineated for the reader.

Karen Perlbachs, Hazelwood Elementary School, Renton, Washington.

Ms. Perlbachs has written and been awarded two school district technology grants. In her article she discusses the grants and the resulting integration of multimedia technology into her sixth grade classroom.

Susan McGrath, Hidden Springs Elementary School, Moreno Valley, California.

Ms. McGrath discusses the use of hypermedia in an elementary resource room. Instruction in the resource room centers around a year-long theme and incorporates the use of word processing, graphics programs, and the construction of HyperCard stacks by the students.

Marilyn Heyn, Hazelwood Elementary School, Renton, Washington.

The New Grolier Electronic Encyclopedia (1990) has been incorporated into the social studies instruction of Marilyn Heyn's third grade mainstreamed classroom for a year. Ms. Heyn discusses the preparation of her students to use the CD-ROM hardware, the integration of the electronic encyclopedia into an instructional unit, and the issue of plagiarism.

Louise Wilson, University of Minnesota, Minneapolis, Minnesota.

Ms. Wilson describes the excitement associated with the use of the multimedia development tool, Linkway, by fifth grade students. She describes several possible applications of Linkway for students in special education classes as well as students in mainstream classes.

Vera Risdon, Hazelwood Elementary School, Renton, Washington.

Three years ago Ms. Risdon, an elementary school principal, said "Yes" to a hypermedia research project involving teachers and students at her school and a group of researchers from the University of Washington. Her article presents her observations of technology in the school setting during those three years as well as many insights into the day-to-day use of hypermedia in an elementary school.

Elaine Montoya Prickett, Kit Carson Elementary School, Albuquerque, New Mexico.

For two years Ms. Montoya Prickett has incorporated multimedia instruction into her second grade classroom in Albuquerque, New Mexico. Her article describes the use of multimedia in a setting that is both unique and challenging. The results of her multimedia project are presented.

Randall Boone and Kyle Higgins, University of Nevada, Las Vegas.

The reactions and perceptions of teachers and students to the integration of hypermedia into their classroom reading programs for three years are discussed by Drs. Higgins and Boone. The data presented were collected at the end of a three-year longitudinal study involving the adaptation of basal readers (K-3) to a hypermedia format.

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Teacher Training in Multimedia: Content Enhancements and Considerations for Instruction

By Cheryl Wissick

Articles on multimedia, announcements for conferences with multimedia themes, or evaluations of multimedia materials can be found in the publications of a variety of educational disciplines. Educational technology and computer-oriented journals along with journals on curriculum, instruction, educational research, and special education have featured teachers and schools using multimedia for restructuring, cooperative learning, and classroom integration of technology. Morgan (1991) revealed positive attitudes about educational multimedia from a panel of educators who described multimedia as "awesome, catchy, dynamic, freeing, promising, seductive, smoke and mirrors, and $tupendou$." With such a range of reactions from educators, understanding what multimedia is, underneath all the glitz, seems an important issue. Two questions that have emerged are: (a) How can multimedia affect or enhance instruction? and (b) What are the critical elements in training teachers and students with and about multimedia? This article will address these questions by examining an array of issues associated with multimedia, including: (a) the integration into instruction and (b) the evaluation of the hardware, software, and training issues.

Integration of Multimedia into Instruction

Educational multimedia may be defined as the non-linear or non-sequential presentation of text, graphics, animation, voice, music, slides, movies, or motion video in a single system that involves the user as an active participant. Is there something in this definition of multimedia that implies a direction or focus for instruction? Perhaps.

Author Profile

Cheryl Wissick is an assistant professor in the Program for Exceptional Children and serves as Director of the Educational Technology Center in the College of Education at the University of South Carolina, Columbia, SC, where she teaches courses in both multimedia and learning disabilities. Dr. Wissick's research interests include the learning theory basis for the use of multimedia in teaching students with midl disabilities, the development of video-based simulations for students with developmental disabilities, and the motivation and social aspects of interactive instruction. She is co-chairperson of the Association for Interactive Multimedia (AAIM), South Carolina Affiliate. For more information, contact: Cheryl Wissick, Ph.D., University of South Carolina, 274 Wardlaw, Educational Technology Center, College of Education, Columbia, SC 29208.

Cheryl Wissick

Meeting individual student needs appears to be a fundamental component in designing and using educational multimedia. The learner can interact with the program and access information in a non-sequential fashion, a manner that is consistent with individual learning needs. Designing instruction to meet individual needs is a primary goal of special education teachers. Multimedia, therefore, offers unique possibilities for special education teachers to enhance instruction for students with disabilities.

Two good reasons for teachers to use multimedia in their classrooms are: (a) to enhance their instructional repertoire and (b) to elicit specific learning behaviors from the students. Multimedia can be used for presentations by both teacher and students, in learning stations, and for student research or "creation" stations. These three applications can be related to instructional events described by Gagne' and Briggs (1979) (see Figure 1).

Teachers can use multimedia programs to elicit certain behaviors from students through its power to motivate, hold attention, present

Figure 1

Multimedia Applications	Instructional Events (Gagne' & Briggs, 1979)
PRESENTATION	Gaining attention Informing student of objectives Stimulating recall of prerequisites Presenting the important content
LEARNING STATION	Providing learning guidance Eliciting performance Receiving Feedback
RESEARCH STATION	Assessing performance Enhancing retention and transfer

Multimedia and instructional events.

content, and deliver activities that encourage cognitive processes. Table 2 provides an overview of multimedia enhancements as they relate to instructional events and student behavior.

Presenting Content

By incorporating multimedia into the presentation of content, the teacher is using it as a tool. Taylor (1980) associated the role of computer-as-tool to productivity programs such as word processors, spreadsheets, and databases. The use of multimedia for presentation is an extension of this tool concept in terms of increasing the productivity and effectiveness of a teacher for whole class or group instruction. Teachers and students alike can use multimedia presentations

Figure 2

Eliciting Behavior of the Learner

Enhancing Instructional Events	MOTIVATION	ATTENTION	COGNITION	CONTENT
Presenting Content	Content material supplemented with a dynamic visual presentation.	Students receive frequent feedback and have frequent opportunities to answer.	Students generate problems from the material presented.	Teachers can use visual presentations to create a context for learning.
Providing Learning Guidance	Students interact with interesting simulations based on fantasy or real situations.	Students have direct manipulation of materials.	Students can explore different paths to locate answers in a process of discovery learning.	Practice and tutorials use original video and audio to present learning situations.
Assessing Performance & Enhancing Retention	Students can make personal choices about their final products & presentations.	Students are involved and interact with each other in the process of creating with multimedia.	Students have to engage in non-linear problem solving to create linkages in projects.	Students have direct access to original materials with slides, movies, and audios.

Instructional integration of multimedia.

to enhance any subject matter lecture or report. Animation, still-frame and full-motion video, and high quality audio can supplement lecture material to make it more realistic for the audience.

Teachers have been using slides, films, and videotape to augment their lessons for years but multimedia offers the capability for combining several media into one unit that is interactive rather than just a pre-programmed delivery system. In addition, videodisc technology gives a teacher rapid access to video-based material and provides high-quality still frame presentation not generally available with videotape. In this presentation mode, teachers can focus on the instructional events of gaining attention, informing students of objectives, stimulating recall of prerequisite information, and introducing important content (see Figure 1).

Instructional features. Multimedia presentations using videodiscs can motivate students by enlivening content material with dynamic visual representations of concepts or events. Links to material previously seen and discussed can be made to new material, thereby stimulating recall of prerequisite knowledge. These links may be controlled by a computer, however, if a teacher wants a less technical presentation format without worrying about computer controls or cables, the videodisc player can be accessed with a remote control or a barcode reader providing students with varying levels of control and interactivity in instruction.

Teachers can access videodisc-based courses for direct instruction of concepts in a particular content area. Research on math and science videodisc courses indicated that students, both learning disabled and non-handicapped, who received the videodisc instruction learned significantly more than the students in traditional programs (Engelmann & Carnine, 1989). Teachers found the programs manageable and that it was also easy to incorporate instructional techniques such as frequent feedback, opportunities to answer, and high engaged time.

Using specially produced educational videodiscs or videodisc versions of feature films, teachers can "anchor" instruction by providing students with problem-rich situations. The Cognition and Technology Group at Vanderbilt University (1991) has been working on a series of videodiscs that situate instruction in meaningful narrative contexts that allow the students to explore and generate both problems and solutions. The *Jasper Woodbury* series of video-based adventures that has been developed at Vanderbilt focuses on mathematical problem solving and provides an example of the interdisciplinary nature of multimedia. Situations that Jasper and his friends encounter, such as the rescue of a wounded eagle, can be related to activities in math, science, and social studies. Teachers who do not have access to the Jasper series can adapt feature films such as *Raiders of the Lost Ark, Star Wars, or Young Sherlock Holmes* to provide similar motivating lessons for various subjects (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987). Through the use of video-based material teachers mediate the instruction by arranging an environment in which learners will be exposed to certain situations and experiences, thereby assisting the learners to distinguish important information from incidental, and to connect past experiences to the present situation (Hasselbring, Goin, & Wissick, 1989).

Teachers can also view a videodisc as a book with 50,000 pictures

(Bull & Cochran, 1987). Any picture in the book can be accessed within about three seconds to provide visual images for the content material. Together the students and teacher work in this shared context locating images appropriate for the lesson and defining language appropriate to the situation (Bull, Cochran & Snell, 1988).

Instructional concerns. In developing multimedia presentations, considerations for the format and ability to anticipate responses from the audience are crucial. Multimedia can enhance a lecture by providing appropriate video to illustrate specific information. However, multimedia should not be viewed as just a vehicle for delivering instruction that is based on current teaching models (Ulmer, 1990). We need to use multimedia to progress beyond the lecture format. The developer of the presentation must anticipate reactions to the material in order to incorporate effective links between related topics that provide the additional information of interest of the students.

Additional concerns about hardware prompt teachers and administrators to create innovative solutions. Using a videodisc player with a large screen monitor is usually sufficient for whole class teaching, however, when both a computer and a videodisc image must be displayed to a large group then additional projection devices must be available. Teachers who teach in various classrooms also need to consider the portability of their multimedia presentation equipment. Once technical obstacles are overcome, the transition between using multimedia to present content and using multimedia to provide learning guidance fits easily into the classroom structure.

Providing Learning Guidance

After a teacher introduces the content of a lesson, she/he provides learning guidance, elicits performance, and provides feedback on that performance (see Table 1). When used to provide learning guidance, multimedia takes the form of tutor (Taylor, 1980). Programs that provide learning guidance (e.g., computer assisted instruction or CAI) are often categorized as: (a) drill and practice, (b) tutorial, or (c) simulation. After conducting a meta-analysis on 63 studies that used interactive video instruction, McNeil and Nelson (1991) indicated that the use of multimedia with videotape or videodisc allowed the developers to incorporate aspects of drill and practice, tutorial, simulation, and sensory motor skills all in one program. The average overall effect size for interactive video (IV) in their study was positive and also slightly higher than those previously reported for computer assisted instruction (CAI). The ability of multimedia or interactive video to depict real-life situations with applica-

tions for a variety of instructional outcomes (i.e., practice of facts, psychomotor skills, application of rules/principles, problem solving) and varying levels of instruction might account for this difference between IV and CAI.

Instructional features. Students are motivated with the realistic "you are there" features of multimedia. Simulations based on fantasy or popular feature films provide students with motivation and continued enjoyment when they can view and interact with their favorite scenes (Wissick, Berdel, & Foelber, 1989). Students also interact with increased incentive if simulations are based on realistic situations that they might encounter. Students maintain attention because they have direct manipulation of these materials to solve the problems. Although a teacher might suggest strategies or ask leading questions, students can explore different paths to locate their answers using the non-linear capabilities of multimedia.

In addition to programs that are specifically designed for learner guidance and practice, programs developed for large group instruction can be modified for individual student use. Creating a learning center with multimedia presentation materials provides the teacher with additional means to individualize for students who require extra practice or who are absent and miss the initial introduction to the material. Although students who view a lesson individually might not have the experience from the teacher direction and class interactions, they will be exposed to the original content. When students are absent, teachers seldom have time to repeat the content presentation for just those students. In this situation, multimedia acts as an assistant or aide for the teacher.

Multimedia also extends possibilities for creating simulations and applications for students with moderate or severe disabilities. Students with such handicaps might have difficulty relating to representational graphic designs to depict community situations or functional items, but can recognize and discriminate such elements when presented through realistic video. Research undertaken to evaluate a prototype community skills videodisc-based simulation indicated that students not only recognize and discriminate but also can acquire the skills to complete a functional task in a simulated setting (Wissick, 1990).

Instructional concerns. In order to use multimedia to provide learning guidance, a match needs to be created between learner and the difficulty level for navigation through the program. Learner control issues depending on student ability and the goals of the

assignment need to be addressed by the teacher (Locatis, Letourneau, & Banvard, 1990). Research indicates that students with high prior knowledge and ability can work more effectively with programs allowing learner control than students with lower ability and similar prior knowledge (Gay, 1986). Students without prior knowledge will need to be guided by the teacher or the multimedia program until they reach a level of proficiency to access the learner control options. On a positive note, Burwell (1991) indicated that students who were tested as field dependent or who tended to accept information at face value benefitted more from multimedia instruction than students classified as field independent. Apparently the multimedia programs did not intimidate the field dependent students and fostered a spirit of exploration. Although multimedia can provide realistic simulations the teacher still needs to act as the mediator for instruction. The teacher guides the learning and provides the students a context in which to explore.

Teachers also need to examine programs for the links that they allow or encourage. Teachers and designers should be consistent with screen design by using color or patterns to denote changes in levels or using sound to cue links. Many programs use icons to depict menu selections. For some students with disabilities teachers may need to teach the students how to use the icons and offer strategies for the students to remember what the icons represent.

For presenting content, a teacher may need access to multiple multimedia stations if students are to use multimedia programs for learning guidance. Cooperative groups working at a station can reduce the need for equipment. Results of the comparison of cooperative groups versus individuals indicated that students working in groups of two to three attained higher scores than students working individually or in larger groups (Cockayne, 1991). However, students working in groups sometime take longer than students working individually due to time needed for discussion and reaching consensus on answers. Students working together can often assist each other with program control and problem solving that they might not have as individuals. An additional benefit of cooperative groups is that they lend themselves to students working creatively to enhance retention and transfer.

Enhancing Retention & Assessing Performance

One purpose of education is to have students gain knowledge to apply in new situations or solving problems in real life situations. Therefore, critical instructional components of a lesson include as-

sessing performance and providing activities to enhance retention and transfer (see Table 1). At this level multimedia becomes the tutee (Taylor, 1980), in which the student is in charge of the teaching. Students can use the computer for their own reports by working as the researcher, designer, developer, and finally, producer.

Instructional features. D'Ignazio (1989) described students and teachers as multimedia explorers, willing to take risks, make mistakes, and improvise. Students experience self-efficacy because they make personal choices about their projects and even act as producers and developers for teachers who have little time to devote to developing multimedia lectures. Students then learn how to interact with teachers as clients and develop products according to their client's outline or specifications.

With this concept of tutee or student as researcher, the process rather than the product becomes important (Bull & Cochran, 1991). A final product might be produced faster under a more traditional situation, however, the experience of solving a problem that can then relate to other situations just might be more important than the product. Students have to work together in the process of creating a multimedia report to coordinate video, audio, text, and assemble the components into a presentation format. Students are thereby engaged in problem solving beyond just one solution to a problem or one connection between pages in order to create links in their projects. They create the links, pictures, or definitions for words that they consider important to the overall theme and for words they feel may cause confusion. In addition, the process of creating a multimedia project can make students aware of how media can be used to manipulate or alter the emotions or perceptions of an audience.

With CDs, videodiscs, slides, and tapes, students have access to original information on events in history. If students want to relate past information to a current situation in their community, they can produce their own photographs or videos to be added to the report. After students conduct in-depth research on specific topics and develop multimedia reports to present the material, they become the experts in their class and possibly the school on that topic (The Cognition and Technology Group at Vanderbilt, 1991).

Instructional concerns. As with any learning activity, teachers must guide the learning and creative process of students producing multimedia projects. Teachers must be perceptive to separate out the content versus the production quality and to teach students to value the information over production effects. Huntley (1991) de-

scribes the danger in multimedia to accelerate our preoccupation with style, appearance, and visual effect at the expense of intellectual content and emotional depth. Both teachers and students should be aware of the glitz and fancy wrappings of a multimedia report. If teachers or students become absorbed by the media or the authoring system, then they frequently spend too much time on the graphic details or isolated parts of text. Students also have to learn about copyright laws in order to be ethical multimedia producers.

Once students complete their multimedia projects, teachers must develop criteria to evaluate the products. Multimedia projects and research do not lend themselves to simple assessments with right and wrong answers. Teachers have to gain expertise in evaluating projects that might have outstanding content but poor design and presentation quality versus those projects with fancy graphics, color, animation, and other effects that may lack substantial content. In an effort to evaluate the outcomes of learning with multimedia, students can create portfolios of their work, providing the teacher with a progression of skills throughout the year. With importance placed on process, teachers can have students maintain logs or journals of their work. Students can record insights about the content material and comments about the process of working cooperatively with other students. Although portfolios and multimedia reports may not provide the same type of performance data as achievement tests, it appears that the experience gained through these projects will provide students with skills that they will use in life-long learning.

Evaluation of Multimedia Issues

To utilize the advantages of multimedia to enhance instructional events, teachers and administrators must make decisions about hardware, software, and training issues. Aside from the usual education funding problems, other questions about hardware and compatibility arise. Griffin (1991) described getting started with multimedia computing as a construction zone with warning signs. The construction in multimedia provides us with the opportunities to build enhancements for instructional events. The warning sign notifies us to beware and pay close attention to details in order to avoid dead ends and detours.

Issues in Dealing with Hardware

Schools cannot wait until the dust clears and the construction is finished to buy equipment. Teachers and administrators will have to

be flexible, realizing that the lowest cost system may not be the most efficient and vice versa. Buying hardware one piece of equipment at time, such as a videodisc player and a monitor, then adding a computer, speech adapter, and video overlay later on, would allow teachers to begin teaching with their multimedia tools throughout the acquisition process. Another option would be to use the computer only to produce hypertext materials (e.g., no video component) and not use the video or speech options until funds become available for that equipment.

The issue of one- or two-screen presentations can be addressed from both financial and education perspectives. On the surface, the use of a computer with a video overlay board that allows for the text, graphics, and video to be displayed through the computer monitor appears to be more cost effective than using a separate monitor to display the motion video. However when the prices of the external monitor versus the internal board are compared, one notices that the two-screen solution can be less expensive and might work just fine in the initial stages of multimedia exploration.

Some teachers are more comfortable with two screens, allowing pertinent text to be displayed on the computer screen simultaneously with full screen video playing on the external monitor. Using one screen, the amount of text and the size of the video window must be decreased. A one-screen system, however, allows the learner to focus attention in one place rather than moving between two displays. Depending on the educational application, both one-screen and two-screen multimedia systems can be effective. Teachers should not feel they are depriving the students if they can only afford the hardware configurations for a two-screen display. When funds allow for both types of display then the teacher can choose the most appropriate for the lesson. Nevertheless, whatever the hardware configurations, teachers need to have the technical support to attach all the equipment and ensure the compatibility of the components.

Presently videodisc seems to be the preferred and most efficient mode for presenting full-motion video. However the technology is advancing such that full-motion video might be available soon on CD-ROM or even computer networks. Until the time that full motion video is easily accessible through computers, we will continue using videodiscs. With the recent emphasis on multimedia in education, numerous videodiscs with relevance for all subject areas have been marketed.

Two formats of videodisc are available, CAV (constant angular velocity) and CLV (constant linear velocity). With a CAV videodisc the teacher can easily locate and isolate individual frames using a remote control, a barcode reader, or a computer program. Although CLV videodiscs are less expensive than CAV videodiscs, they can not be searched by individual frame number and so are generally used as a linear film. One disadvantage of videodiscs is that they only allow for 30 minutes of motion video on a side and do not have the ability to play audio from one part of the disc and display a single frame from another part of the disc simultaneously.

When developing programs with videodiscs, teachers frequently want to interchange video from either side of a videodisc or even use different videodiscs within the same multimedia program. Although it is possible to use several videodiscs, the programming to notify the students which videodisc should be in the player could be problematical and the necessity to change the videodiscs frequently could be annoying and time consuming for the students. The technology is changing rapidly, however, and with the addition of speech adapters and CD-ROM drives, teachers now have the ability to record their own speech or music to accompany videodisc images.

Some schools in South Carolina are adopting a model for multimedia establishing a "creation station"[1] in the media center that is networked to the computers in the classroom. The students may use the multimedia authoring programs to view videos and construct the base of their program in the classroom but only have the ability to complete the finished product at the creation station. The station is equipped with a computer, videodisc player, CD-ROM drive, speech cards, video cards, and a VCR. The students record their final reports on videotape to present to the class or submit to the teacher.

Issues in Choosing Software, Authoring Systems, and Video

Whatever the hardware solution, teachers and administrators also need to evaluate commercial programs and authoring systems in an effort to make their use of multimedia effective. If cost is a factor, programs that allow different hardware configurations with possibilities for expansion should be considered. Teachers can seek out other commercial programs that offer the possibility to use only the video-

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1 Credit for the term, "creation station," goes to Donna Elmore, Orangeburg District V Public Schools, South Carolina.

disc as a complete program or also have computer programs that provide interactivity. Teachers can also use hypertext programs that provide interactive text and graphics without additional sources of video and sound. No matter what software programs are used, checking the hardware requirements should be the first step before ordering any new programs.

Going a step beyond ready-to-use commercial programs, authoring systems provide teachers with the tools to create multimedia programs without having to learn a complete programming language. Authoring systems furnish a teacher with the possibility to create programs specific to individual student needs. Unfortunately, authoring can take time. In addition to designing the initial concepts for instruction, creating a multimedia program requires organizing the information, creating text, designing graphics, and creating the final links. Teachers must balance the amount of time necessary for creating quality educational multimedia with the extent of use it will receive by students and other teachers. A solution to creating a completely new program from scratch is the use templates or shells, which are previously created frameworks for the organization of the material that include all the essential programming. Templates allow the teacher to create individual programs and modify the text or video for their students without performing the complex programming (Boone & Higgins, 1991; Wissick, Berdel, & Foelber, 1989).

Authoring systems also provide the teacher with the tools to "repurpose" or design a new purpose for commercial video. Feature films and generic "picture" discs offer numerous possibilities for creating units that are viable in more than one curriculum area. As photographers and state libraries or archives continue to document their accumulation of slides on videodisc, the possibilities for classroom use increase.

Issues in Teacher Training

Most important, the potential of multimedia lies in the hands of teachers. How the teacher incorporates multimedia into the curriculum dictates its effectiveness. Therefore, teacher training needs to include not just programming and knowledge of the equipment but also an introduction to the learning theory that supports the use of multimedia and instructional design techniques that enhance multimedia. Teachers need to be taught in settings that model appropriate, effective use of the technology. Multimedia can be integrated into all content areas creating opportunities for interdisciplinary units. This will not happen, however, without those skills being modeled in

teacher training.

How "computer literate" does a teacher or media specialist need to be to learn how to use multimedia? What are the prerequisite skills for a teacher to learn to use multimedia in the classroom? A teacher must feel comfortable with the technology. Feeling comfortable with the technology does not mean that a teacher has to take numerous courses in computers and related technologies. Teachers with little computer background can use a videodisc player and remote control or barcode reader to present video-based material to their classes. Teachers with experience using computers in the classroom might be more inclined to see the potential of creating their own lessons or repurposing existing programs with commercial videodiscs, however. For example, teachers who begin using *Raiders of the Lost Ark* or similar films to work on science and social studies project might find themselves considering possibilities for instruction or repurposing every time they watch a newly released Hollywood production.

A teacher with little or no experience using a computer can author a multimedia program if provided with at least a week-long workshop in authoring. Teachers with little technology background have to realize that it will take them longer than other teachers to learn some of the basic skills such as mouse manipulation skills and file management. In addition, their final products might not be as sophisticated as someone with prior computer experience.

Inexperience with using a mouse, a frequently used input device for multimedia systems, and the change from the keyboard can increase the length of time it takes a teacher to reach a feeling of proficiency with an authoring program . The teacher who enjoys working with the technology, is proficient using a computer for word processing, and can manage files efficiency should be able to make a smooth transition to multimedia development.

Teachers who just take a workshop to learn an authoring language frequently do not incorporate the non-linear aspects into their projects. They understand the interactivity but do not incorporate the non-sequential access to information. Instead they have the learner complete each page of the final program to reach the end instead of allowing them to access the information as needed and achieve the final goal in an alternate pattern. Teachers who have not had much exposure to technology but read articles on multimedia use and applications have little understanding of the programs without being involved in the process of a programming project. Courses or workshops on multimedia need to incorporate and balance aspects

of educational theory, instructional design, and programming.

One final consideration involves teacher beliefs surrounding the length of time necessary to see the effects of multimedia instructional materials. In an evaluation conducted on the Apple Classrooms of Tomorrow project, Dwyer, Ringstaff, and Sandholtz (1991) noted that change takes place over several years as teachers and students move through levels of entry, adoption, adaptation, appropriation, and invention when using new technology in their classroom. As teachers and students move through levels of use with multimedia, additional integration into the curriculum occurs at each level. The researchers also observed that learning in the classrooms became a more active, creative, and socially interactive process over time than when the program first began.

Summary

Multimedia provides teachers with a powerful tool to access and present a combination of media for enhancement of instruction events. Furthermore, multimedia provides the learner with a non-sequential means to interact with a combination of media thereby increasing motivation, maintaining attention, stimulating cognition, and illustrating content or facts. With multimedia, teachers have new potential to change the way schools are structured and the way they teach.

How can multimedia affect or enhance instruction?

- Multimedia has the potential to enhance instruction at all levels of instructional events but teachers should integrate it into instruction using it as a tool instead of just a supplement to the curriculum.
- Instructional designers and developers should go beyond the traditional models for instruction that have driven technology development in the past. Developers should be encouraged to create templates for teachers allowing them to incorporate their own text, graphics, and video into advanced programs without dealing with the details of programming.
- Multimedia programs need to be developed for use with different hardware configurations allowing teachers who do not have all the hardware access to certain aspects of the programs as they build on their configurations.

What are the critical elements in training teachers and students with and about multimedia?

- Teachers at any level of technological expertise can use and even develop multimedia applications if they are provided with: (a) the technical support to ensure that all the hardware components are compatible and (b) training in both instructional design issues concerning multimedia and an authoring system.
- Teachers and students must be aware of the "big picture" or the overall goals of the lesson, so they are not swept away with the glitz attending only to the production and not the content.
- Possibly, the greatest potential of multimedia is that it allows teachers to create environments where students can be researchers and creators of products for reports or to assist teachers with multimedia allowing students to become experts on specific topics.

The full potential of multimedia applications has yet to be realized. Teachers and students will continue to use multimedia to perform feats previously thought improbable if not impossible in schools.

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Envisioning, Acquiring, and Running a Multimedia Lab in Your Classroom

By Karen Perlbachs

Last year with the opportunity to teach sixth grade and having recently become a computer enthusiast, I decided that I could integrate the computer into the curriculum more easily working with older students. So I left behind the "primary wing" Apple //e and acquired an "intermediate wing" Macintosh SE.

I went to visit my new room. Although the physical atmosphere was less than inspiring with some hand-me-downs and mismatched desks, my greatest asset was the new Macintosh computer. I had a determination to give my students a taste of the exciting world of technology.

My multimedia setup initially included only a Macintosh SE in my

Author Profile

Karen Perlbachs became interested in HyperCard and its applications for education through her affiliation with a federal grant project that was conducted at her school. She was enthusiastic enough about its potential to enroll in a program for a Master of Education degree in computers in education. Karen completed the program in December 1990. Since that time she has become a university adjunct faculty member teaching computer application courses for teachers in addition to teaching sixth grade. For more information, contact: Karen Perlbachs, Hazelwood Elementary School, 6928 116th Ave. S.E., Renton, WA 98056.

classroom, along with a TV set, VCR, and video camera checked out from the district visual aids library. But the district did have a small budget for mini-grants, a program allowing teachers to apply for up to $1500 per request for innovations that improve instruction and provide a direct benefit to students. I decided to utilize the Mac and some existing resources as part of two different proposals in hopes of getting at least one. I received BOTH!

Multimedia: Developing Multicultural Awareness Through Technology and Writing Skills

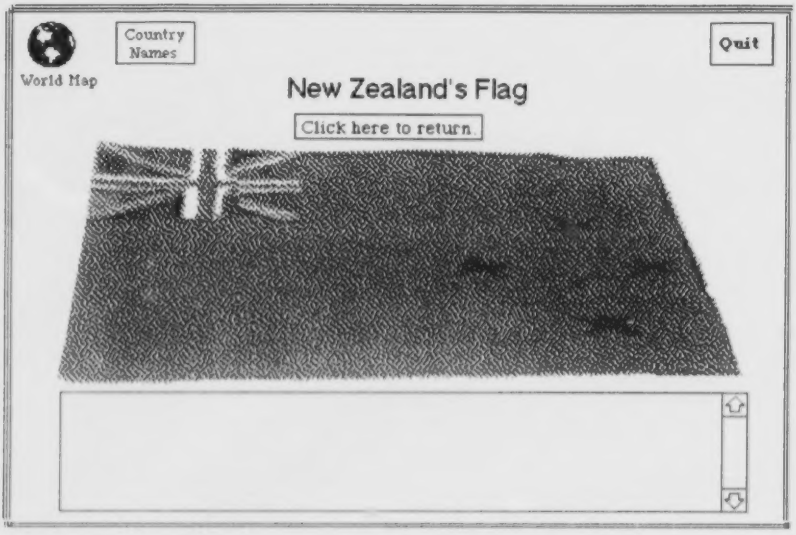
The first grant, *"Multimedia: Developing Multicultural Awareness through Technology and Writing Skills,"* utilized the existing video camera, HyperCard (Atkinson, 1987), and the Mac. I ordered a liquid crystal display (LCD) with a Mac adapter for the overhead projector for about $1000 and a video digitizer for about $200. I envisioned the students digitizing maps, pictures, and real-life scenes that could then be incorporated into computer produced reports (a HyperCard stack). The focus would be on enhancing multicultural study while reinforcing geography, written language, and organizational skills.

While we waited for the order to arrive, the students each selected a country of interest. They gathered information and produced a hand-drawn map and flag. I supplied an outline designating areas of focus and the students began researching and preparing their reports.

The LCD arrived first. I used it to introduce HyperCard through whole group instruction. All of the students learned to create and copy HyperCard stacks, create and name buttons, copy and paste pictures, and create and link cards. I assisted the first students in utilizing what they had learned in theory. From then on when they finished their other work and at recess, they helped each other. There were only two rules for working on the computer: (a) only one person at a time had control of the program and no other person could touch the keyboard or mouse without permission, and (b) a file was the private property of the creator. I would check their files, but they were not to invade someone else's privacy by opening another's file.

When the digitizer arrived, the students rapidly learned to connect it and use it with the video camera to capture pictures of themselves and their hand-drawn pictures. They worked in groups of three - one on the keyboard, one on the camera and the other as the subject or the adjuster of the position of the flag or map pictures (see Figure 1). The students rotated from job to job so that everyone had

Figure 1



Students used a scanner to digitize facsimilies of flags for their World Cultures HyperCard stack.

an opportunity to do each of the tasks. We could have digitized pictures from books or copied clip art maps. But I believed the students would have a better awareness of geography if they had to locate their country and then focus on the surrounding countries as well.

Working with the HyperCard drawing tool to make maps and pictures would have provided excellent quality graphics, but this would have taken an inordinate amount of time. Because we were limited to one computer for twenty-eight students, the digitizer was a rapid and fun way to add graphic interest to the projects. I designed a stack template as a frame for the computerized reports. The students then copied the stack template to a personal disk, later copying the digitized pictures into the class stack and entered the

information from their reports.

There were no problems surrounding the technology. Time was the greatest problem. When it was time to enter the text of the reports into the stacks, the students' keyboarding skills caused the process to be very laborious. I was fortunate to have one parent who gave up her days off to input the information, but we were still unable to get more than a few reports entered.

As an aside project we extended our use of the grant to one of our kindergarten classes. Each kindergartener had a sixth-grade friend. Together they prepared poems about each other and put the writing into a book with a digitized picture of each of the partners. And as another benefit, the LCD came in handy for other instructional purposes such as outlining and grammar and mechanics corrections on screen.

Next time.... I will start slowly and *simply*. Next time I will keep the reports simpler because time, or rather the lack of enough time, is the greatest problem in a one-computer classroom. Next time I will focus on *one* area for writing - customs, recreation, or the like - which will simplify the stack template design as well. Next time I will have groups of two or three students create one report.

But next time I will continue to have students draw and then digitize flags and maps showing the country and its neighbors. I will also continue to have them work in groups to take digitized pictures of each other because this is not an artificial cooperative situation but a necessary one - it not only was reinforcing for all concerned with the pictures captured and saved, but no one could avoid being involved.

Integrating Science and Language Arts Through Technology in the Elementary Classroom

The second grant was entitled, *"Integrating Science and Language Arts through Technology in the Elementary Classroom."* I ordered a laserdisc player (about $800 with a special that included a free barcode reader) and the BioSci II Videodisc (Lippke and Johnson, 1990) (about $500). I had a public domain video driver stack from a multimedia class I had taken, and we had an old Commodore in the building with a keyboard that didn't work so I confiscated the monitor for a good color display. When the laserdisc and player arrived, we learned together how to hook up and access the BioSci slides and movies. I had learned an important rule from the social

studies grant project: KEEP IT SIMPLE AT FIRST. I kept this in mind and started slowly. The students spent free time and recess exploring the many subject areas and slides on the videodisc and how to access them. I had hoped to have them use the Mac and the video driver stack but that would have taken more time than was available since the students were also working on their social studies reports at this time as well. I assigned group reports instead of individual reports. Each group used the science goals and objectives, the library, and the BioSci II videodisc to prepare and present a report on an assigned topic from our Microscopes science unit. Later, I designed a stack utilizing the public domain video driver stack and HyperCard to create reports with buttons that accessed the laserdisc sections chosen by the reporters. Because computer programs are not available that can fully support the school curriculum, this year I will continue to have the students produce reports and prepare stacks in groups.

I feel fortunate to have gotten two grants. I believe I received the grants for several reasons: (a) I utilized existing resources in conjunction with the new; b) both grants focused on the *integration* of technology with multiple curriculum areas; (c) the stated behavioral goals and objectives had specific activities and measurable evaluation procedures; and (d) finally, the projects benefitted the district as a whole because the product and templates could be shared with other teachers and classrooms.

I found the sixth graders able to learn quickly all the necessary skills to produce multimedia reports. But they learned more than just how to use technology. They used outlining, note-taking, library, writing and cooperative skills, and the integration of multimedia as a research tool. They gained more than just academic knowledge and cooperative skills. They now understand that technology is not only conquerable but fun. Use of multimedia also gave the students a great sense of accomplishment, for regardless of their "academic potential," the live presentation of an interactive report was impressive! The year was busy and fun. And *this* year.....!

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Building a Hypermedia Classroom Unit

By Susan McGrath

Start with a group of fourth and fifth grade boys and girls. Label them "learning disabled." Add to that the fact that they are pulled from their regular classroom for one hour a day to remedy their learning deficits in a resource room. And what have you got? A group of students who are not excited about learning, who have low self-esteem, and who would generally rather be anyplace else but in this room.

Make some drastic changes and not only will resource room students change their minds, but general education students will be asking to be tested to get into the resource program. What kind of changes? Changes in the curriculum content, the delivery of content, and incorporating the use of technology.

The curriculum should expose the students to useful, meaningful, experiential learning situations. Technology in the school setting needs to be used as a tool to construct and create, just as it is in the real world. Don't insult a student's intelligence with dry, boring drills, dittos, or electronic workbooks. One method of creating an exciting classroom learning environment begins with a year-long theme around which all learning activities will be based. Using the theme *Systems, Backyard to the World : Everything and Everybody on the Planet is Connected in Some Way* , the resource room activities are organized around six systems:

1. **Ecological System** - the backyard environment to the biomes of the world
2. **Economic System** - the raising of a local farm crop to the product delivered in the store
3. **Social System** - the immediate family to the world family
4. **Body System** - the brain and its structure to its influence on the entire body
5. **Transportation System** - the local airport to its world wide connections
6. **Communication System** - backyard video to major motion picture production.

Author Profile

Susan McGrath has a Masters Degree in special education from the University of New Mexico and has 14 years teaching experience in general education and special education. Before moving to Moreno Valley in 1990, she was a resource teacher with the Albuquerque Public Schools Computer Education Resource Team. She is currently a resource room teacher in the Moreno Valley Public Schools. For more information, contact: Susan McGrath, Hidden Springs Elementary School, 9801 Hiddren Springs Road, Moreno VAlley, CA 92557.

Susan McGrath

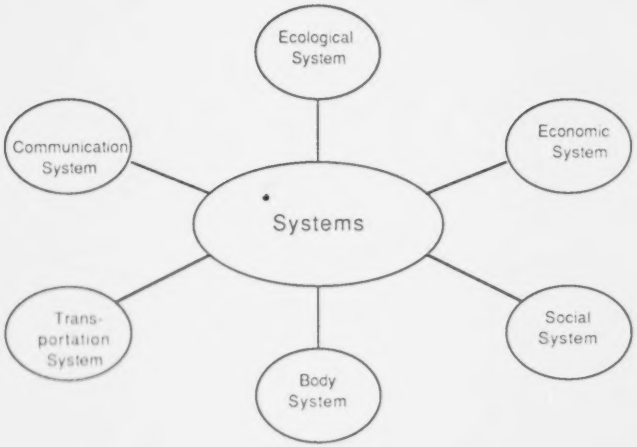
Each system begins in the student's micro world of close-at-hand experience and is expanded to incorporate a related macro system.

Within each of these systems, students learn the basic academic skills required in their Individual Education Plans (IEP's). Using the year-long theme diagram students are introduced to the plan for the year (see Figure 1). Time allowance for each system is approximately six weeks and includes many hands-on activities in conjunction with the use of technology. The theme diagram is also the beginning map for a classroom HyperCard (Atkinson, 1987) stack. Instruction within the theme format began with the Ecological System and is now continuing through the other five systems. While studying the Ecological System component, students were introduced to the individual elements involved in the creation of a HyperCard stack (e.g., word processing, creating graphics with the paint tools, and button linking).

Word Processing

Word processing was introduced by telling a story to the students about an old woodpile in my backyard. "In this woodpile lived a variety of animals: a skink, wasps, mice, rolly pollys, snails, and spiders. Needless to say, when we decided to dispose of this woodpile we disturbed a mini-environment; we destroyed their homes." Students

Figure 1



YEAR LONG THEME DIAGRAM

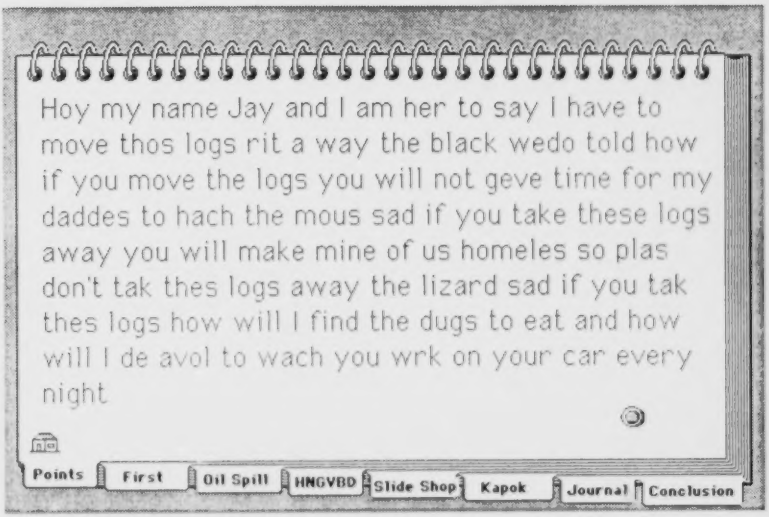
A year-long theme of interrelated systems provides a framework for integrating computer use in the resource room curriculum.

were asked to retell the story using pencil and paper. Allowing students plenty of time to think and write was important as was the assurance that spelling didn't matter on this draft.

I entered the students' stories exactly as they had written them...spelling errors, punctuation errors, reversals and all into the Macintosh using a word processor. I printed a hard copy of each of their stories. Students were excited to see their work in print and, because I had chosen a large font size (24 pt), were surprised at how much they had written. As they each reread their stories, students spotted many of the reversals and spelling errors on their own now that their handwriting was translated into printed form (see Figure 2).

I grouped the students around the computer and demonstrated

Figure 2


Hoy my name Jay and I am her to say I have to move thos logs rit a way the black wedo told how if you move the logs you will not geve time for my daddes to hach the mous sad if you take these logs away you will make mine of us homeles so plas don't tak thes logs away the lizard sad if you tak thes logs how will I find the dugs to eat and how will I de avol to wach you wrk on your car every night
Points
First
Oil Spill
HNGVBD
Slide Shop
Kapok
Journal
Conclusion

Student writing is first entered verbatim and in a large typeface.

to them how to edit an error. Students particularly liked the idea that, once corrected, no one could ever tell an error had been made.

A variety of related activities provided students with experiences for our next technology activity which linked ecological systems to the Persian Gulf oil spill. My instructional aide read selected parts from the headline story about the oil spill dated January 27, 1991, in the Los Angeles Times, to the students. After a discussion of the article, each student was given a cup of water to which he/she added two spoons of dirty motor oil. Observations were recorded on the chalkboard. Each student was then given a feather from a feather duster to dip into the oil-water mixture. Again observations were recorded onto the chalkboard. Students then brainstormed another list of how to remove the oil from the feather and thus clean the animals caught in

the oil spill. Next, the students wrote paragraphs about how they thought the animals felt having been caught in the oil spill.

Again, I entered their paper-and-pencil drafts into the computer just as they wrote them and printed a copy of each. We edited these stories as a group, each marking his/her own paper. After marking corrections with pencils, students were taught to call up their stories on the computer and make their corrections with technical help from my instructional aide and me. They learned how to format their stories, print them out, and save them. Selecting from a variety of fonts was particularily exciting for the students (see Figure 3).

Graphics

The book, *The Great Kapok Tree* (Cherry, 1990), became the springboard to computer graphics. This tale took place in the Amazon rain forest. "A man came to chop down the Kapok tree. The animals of the rain forest told him why he should not chop down the tree." In a simple recall activity, we wrote the topic sentences on the chalkboard. After brainstorming a list of animals that lived in the ocean, we circled the nouns in our sentences and substituted the names of ocean animals. We changed the premise of the story from a man chopping down a tree to that of a man dumping trash into the ocean. Students each selected one sentence to illustrate on the Macintosh LC using a color paint program. No clip art was allowed. Pictures were printed in color and compiled to create a class book (see Figure 4).

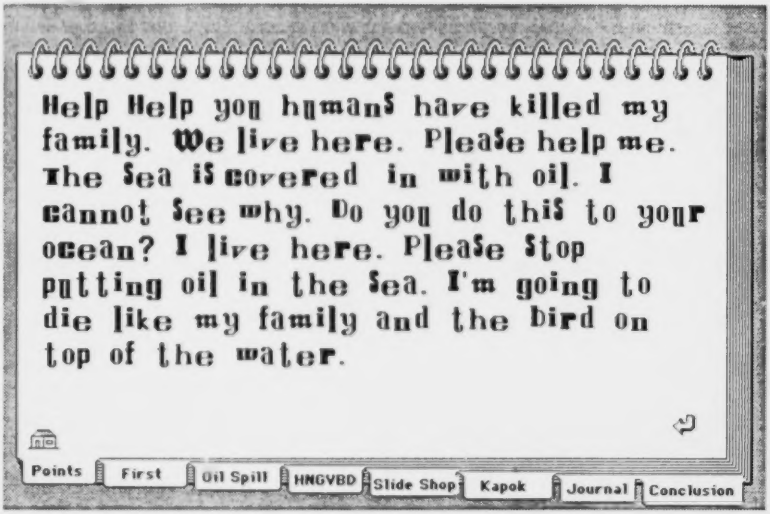
Button Linking

Students were then introduced to the use of the laserdisc player and HyperCard through "The Environment," an activity on the Visual Almanac (Hooper, 1989) from Apple Computer. This activity allowed students to click the mouse on a biome map of the world and then access still frames, video segments, and accompanying information about a variety of animals that live in that particular biome.

The Next Step

This class was now ready to begin creating their own classroom HyperCard stack with a home card labeled "Systems - *Everything and everybody on the planet is connected in some way.*" The diagram created at the beginning of the year was used as a guide for the creation of this HyperCard stack. One common, generic

Figure 3


Help Help you humans have killed my family. We live here. Please help me. The Sea is covered in with oil. I cannot See why. Do you do this to your ocean? I live here. Please Stop putting oil in the Sea. I'm going to die like my family and the bird on top of the water.
Points
First
Oil Spill
HNGVBD
Slide Shop
Kapok
Journal
Conclusion

Students edited and formatted their articles. A variety of fonts gave them a creative choice that they enjoyed.

background was chosen for all cards. Six buttons on the home card linked each of the six systems studied throughout the year. The HyperCard stack was to be a classroom stack, each student creating one card to illustrate a key point learned from each system. For example, using the Ecological System, one or two students could design cards based on our experiential activities, to illustrate the key point: *An environment exists in a backyard.* Another pair of students might design cards based on our activities to illustrate the key point: *What man does can disrupt an environment;* while yet another pair could illustrate, with a card or two, the key point: *Each biome has its own characteristic animal and plant life.* Students will first plan their cards away from the computer with paper and pencil. They will be required to use text and graphics they design themselves in their card creations, using only the tools available within HyperCard. Using a

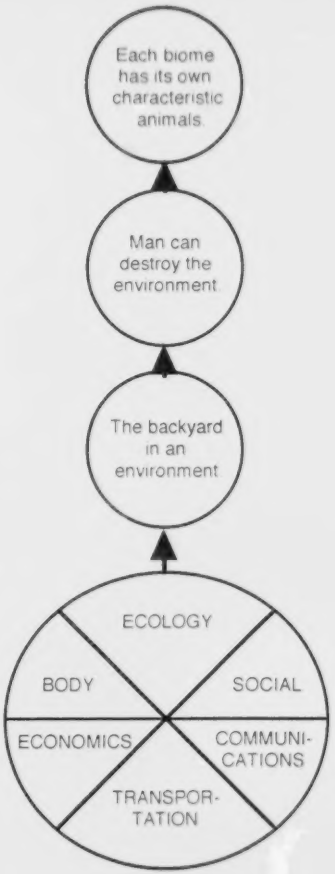
Figure 4

Pictures were created with a paint program before being added to the HyperCard stacks.

classroom bulletin board, the linking of the HyperCard stack will be illustrated by actually linking one card to the next with ribbon using our diagram from the beginning of the year. As each system is studied, more cards will be created and linked until the diagram begins to look like a Sun with six extended rays (see Figure 5).

I anticipate very few problems with the use of text, graphics, and general card design because the students already have a good basic knowledge of graphics creation and word processing. I do, however, anticipate some confusion in the creation of buttons and their links to cards. To solve this problem, we may physically copy and paste buttons on our bulletin board diagram, using the appropriate computer vocabulary as we do it. To introduce the "Go Recent" command we will compare it to our diagram on the bulletin board:

Figure 5



One ray (out of six) of the flowchart for a HyperCard stack is completed.

It's a place where we can see the whole picture.

The initial introductory concepts are likely to be difficult; it will be like learning to ride a bike. It appears very difficult at first, but once you're on, the riding becomes second nature. The students may be confused at first, but with practice, creation of the class HyperCard stack will become easy. As their knowledge becomes more sophisticated, I anticipate the students will create their own links between systems, so that the diagram will begin to take on the appearance of a wheel. Just as the wheel turns and progresses, every student will have the opportunity to learn and grow and meet his/her IEP goals.

Following my introduction last year of the whole-year theme concept, integrated with the use of technology, the Resource Specialist Program (RSP) is no longer dubbed the room for dummies. Students have created a new name... RSP stands for Radical Special People.

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Using a Hypermedia Encyclopedia with Third Graders

By Marilyn Heyn

Evidence suggesting that today's students have positive attitudes toward using computers as a regular part of their school work was clearly born out in my third grade classroom this year. Coming to my class already having a significant amount of experience with the technology, these students were comfortable in coping with a great deal of computer experience during the year, both at home and at school. At least half of the students in my class had personal computers at home and approximately a third had been involved previously in a hypermedia reading program at school. Because of the students' previous experiences, they quickly became comfortable using the new Macintosh computer in the classroom which made learning to use the hypermedia encyclopedia easier and faster.

Author Profile

Marilyn Heyn has been involved in the use of computers in education for the past eight years and has found it to be a most exciting and rewarding part of her 30-year teaching career. Marilyn started using turtle graphics with her class using the Commodore Vic-20, then went to Logo with the Commodore 64, followed by the Apple IIe using problem-solving software, and most recently is teaching with the Macintosh using a hypermedia reading program and an electronic encyclopedia. Ms. Heyn currently teaches third grade. For more information, contact: Marilyn Heyn, Hazelwood Elementary School, 6928 116th Ave. S.E., Renton, WA 98056.

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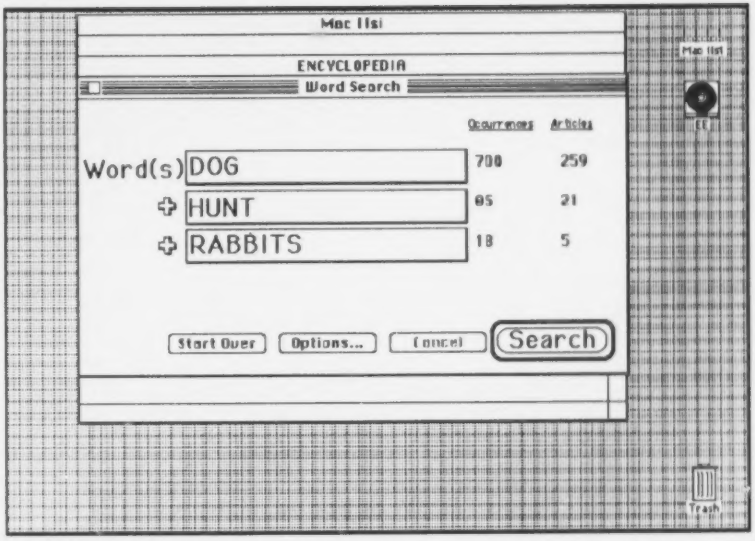
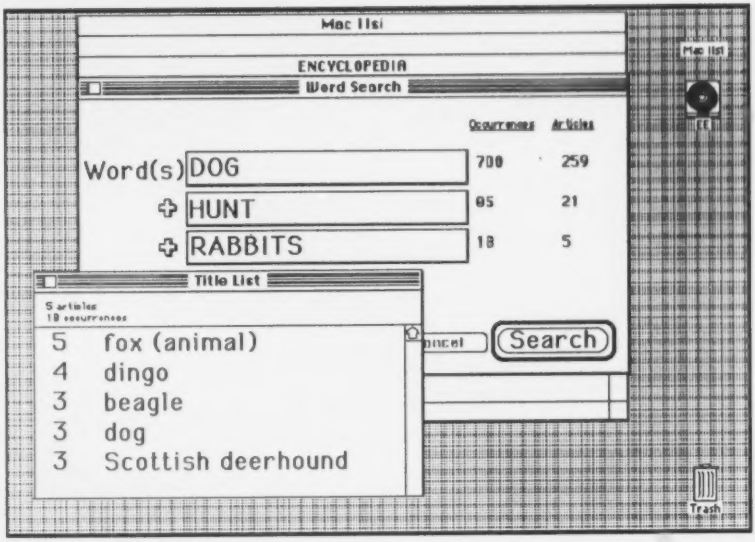
Figure 1



A screen from a Macintosh running the Grolier Electronic Encyclopedia depicts the word search function. A student searches for a type of dog that is used to hunt rabbits by entering the most important word first (DOG) then adds secondary words (HUNT & RABBITS) to help limit the search.

We used the *The New Grolier Electronic Encyclopedia* (1990), a single CD-ROM disk containing an entire 21 volume encyclopedia. The students learned how to search the text of the encyclopedia in three ways: (a) browsing the title index, (b) browsing the word index, and (c) accessing the word search (see Figures 1-4). We started with the simple level of searching by title and keywords. This was a great opportunity for my students to learn research skills. The students enjoyed working with the electronic encyclopedia which suggested titles of articles that they otherwise might not have considered about their topic. When browsing the word index, choosing the topic *Indians* for example, the students were amazed at the number articles available in which there was a reference to Indians. Indians of North America, frontier, slavery, fur trade, Oregon, and Andrew Jackson were only a few of the many key words for articles matching

Figure 2



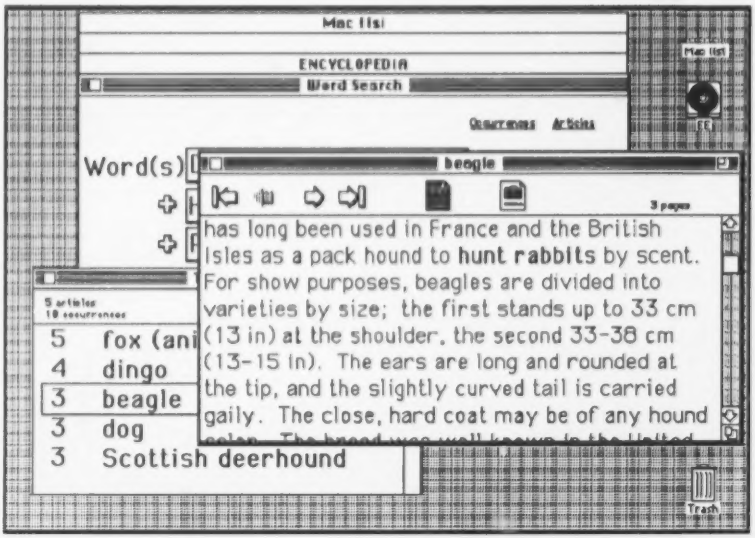
A search of the electronic encylopedia based on the key words DOG, HUNT, & RABBIT produces a list of five articles that include these words somewhere in the text.

this search criteria. The class especially enjoyed the pictures contained in the encyclopedia but were very disappointed they could not print them out directly from the program.

Every student seemed to learn the process within two or three class periods. Students worked in cooperative groups of two and the children were most enthusiastic to assist their peers when needing help. The speed and the immediate accessibility of the electronic encyclopedia helped students transfer these simple search techniques to other kinds of research problems.

One of the first lessons for this project was designed to familiarize the class with a CD-ROM player. Having been previously introduced to a laserdisc player, the class quickly gained an understanding of this

Figure 3

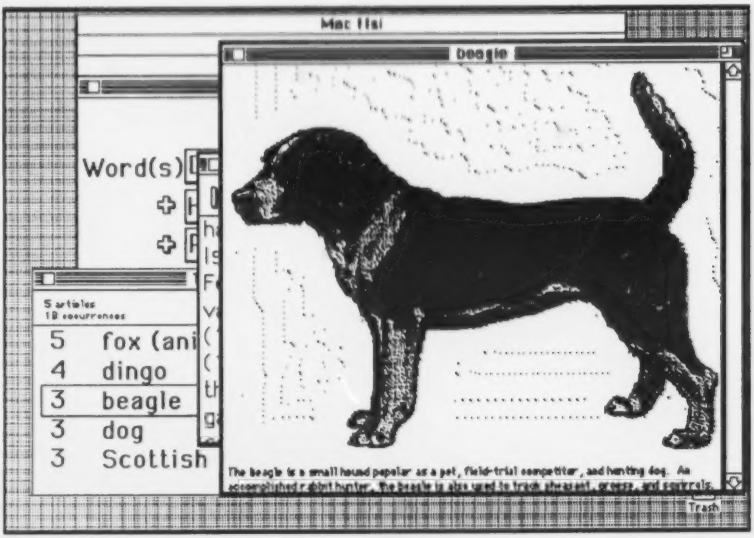

Mac IIsi
ENCYCLOPEDIA
Word Search
Occurrences
Articles
Word(s)
beagle
has long been used in France and the British Isles as a pack hound to hunt rabbits by scent. For show purposes, beagles are divided into varieties by size; the first stands up to 33 cm (13 in) at the shoulder, the second 33-38 cm (13-15 in). The ears are long and rounded at the tip, and the slightly curved tail is carried gaily. The close, hard coat may be of any hound
5 articles
10 occurrences
5 fox (ani
4 dingo
3 beagle
3 dog
3 Scottish deerhound
Trash

Selecting BEAGLE from the list of article titles results in the entire article being presented in the scrolling text window overlaying the other information windows. A camera-shaped icon at the top of the article indicates that a picture is linked to this article.

new piece of hardware. We discussed the terms "optical storage medium" and "laser" to help the students understand how the digital information is sent to the computer where the data is then displayed. As I was learning to use the electronic encyclopedia, I invited small groups to watch as I explored the program myself. I showed them how to access information on certain topics, view a picture, print out the information, and take notes on the electronic notepad.

The next, and probably one of the most important research tools we explored was *note taking*. We incorporated several exercises from our language arts book on taking notes in your own words into the paradigm of the electronic encyclopedia. I stressed the need for them to take notes in their own words and write just enough to help them remember. We first did this by interviewing each other, and

Figure 4



A picture of a beagle appears in a graphic window overlaying the previous information windows when the camera icon is selected. These pictures cannot be printed unless the computer is equipped with a "screen print" utility.

gathering as much information as possible about their classmates. Reports were given orally to the class. They later went home excited over their next assignment, to interview a family member and report back to the class the following day. Many other activities such as this one, worksheets involving picking out the important facts, and taking notes from stories and books the children were reading were used extensively before actually using the software.

One of the last activities before actually using the electronic encyclopedia was a homework assignment to find out the meaning of *plagiarize*. We have had previous discussions on copyright laws and of course learning the meaning of plagiarize led the students to understand that it is unethical and unlawful to take someone else's words and use them as your own. The students learned that it is

acceptable to quote from an electronic encyclopedia, giving credit in a footnote.

As we were beginning to start work on biographies for our social studies unit emphasizing the Pacific Northwest in early American history, each child eagerly chose a person to study. Some of the people chosen for research were George VanCouver, an explorer of the Straits of Georgia; Marcus Whitman, a missionary among the Indians; William Clark, a soldier and explorer; John McLoughlin, a Canadian fur trader; frontier heroes like Daniel Boone; and of course, several past Presidents of the United States. I allowed the class to print out the information they found and then asked them to highlight with a marking pen the important facts for their report. Next they put their notes on 3 by 5 cards in order to give their report orally to the class.

When we finished the biographies, the class started writing their own "myths" based on Native American legends and other stories we had read in class. I soon found them voluntarily using the electronic encyclopedia in search of information on Northwest Indians for ideas to use in writing their myths.

The motivation of the students to remain on task was tremendous. I also feel the cooperative learning approach was particularly effective with the electronic encyclopedia, increasing the students' interest level and enthusiasm. The students saw themselves as responsible for and in control of their own learning. Some of their comments on using the Electronic Encyclopedia were as follows:

"It is easy to look up things, it shows you pictures that are good and it is fun, I like using the mouse."

"You can find things faster."

"It is so easy to just type in the word, click on "go to", click on open and there is your information."

"It is easier than using a book and gives you experience with the computer."

"I like looking up stuff and finding out new information. Fun!."

"It's cool and neat to look at and see people work with it."

This has been a wonderful learning project for me as well as the class. It has been a great opportunity to have this early taste of what computers will eventually do routinely in education. Using multimedia and hypermedia technology as a learning tool in the classroom certainly does make a difference with the students. Their attitude towards learning is greatly enhanced while their self esteem is increased.

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Enhancing Critical and Creative Thinking With a Multimedia Authoring Tool

By Louise Wilson

Imagine a classroom of fifth graders, special and regular education students, buzzing with creative activity. Some are at computers; some are taking notes from an encyclopedia; some are at tables writing and planning; some are using cameras. Now come back to this classroom a few days later when the children are presenting the results of all this activity, a class project on the human body.

From a single microcomputer the children demonstrate the systems of the body with photographs, text, graphics, and narration. By simply selecting certain areas of the computer screen, the students navigate through their presentation, providing varying levels and modes of information about the systems of the human body.

How did they created this impressive technologically advanced project? They did it with a multimedia authoring software system for IBM and compatible computers called Linkway (Kheriaty, 1989). Linkway's software tools supplied the technical, behind-the-scenes programming and structuring while the students provided the thinking and planning for creating the hypermedia presentation.

The Hypertext Concept

The concept of the hypertext environment is the key to an exciting new approach to computers and learning. The term hypertext was coined in the 1960s by Ted Nelson, an early leader in personal computing (Harrington, Fancher, and Black, 1990). Nelson saw the potential for the computer to organize material less like the linear structure of a book and more like the non-linear organizational structure of the human mind, which jumps from idea to idea through associations.

Teachers and students have become more familiar with computers in recent years and are using computers and related technologies

Author Profile

Louise Wilson is a doctoral condidate at the University of Minnesota, doing work with student development of simple expert systems. She offers workshops on Linkway multimedia software as well as other applications of technology to instruction. Prior to her current work, she taught hearing impaired children and supervised programs for deaf and hard of hearing students in Illinois.For more information, contact: Louise Wilson, 1276 Nursery Hill Lane, Arden Hills, MN 55112.

to compose papers, create spreadsheets, communicate via electronic mail, and interact with simulations of otherwise inaccessible phenomena. When using the computer for these purposes, students are no longer passive participants. They become thinking partners with the computer, providing information that the computer shapes, calculates, and refines.

Authoring software for hypertext and hypermedia allows less sophisticated computer users to create exciting presentations, and in the process, experience the value of being a developer through organizing content materials in an effective, interesting fashion. LinkWay is one of a growing number of multimedia/hypermedia authoring programs available for microcomputers.

Using LinkWay

Creating hypermedia or multimedia documents is relatively easy using LinkWay's pull-down menus rather than typing in programming code necessary in more conventional computer languages. LinkWay uses the metaphor of a file folder for organizing content material.

These LinkWay documents, called folders, are organized in much the same way that teachers fill file folders with lesson plans, worksheets, overhead transparencies, and pictures centered on a common topic or theme. Each folder is created around a particular topic, with the pages in the folder represented by separate screens of information presented on the computer screen. These pages can include text, graphics, or pictures about the topic.

LinkWay Folders Created by Students and Teachers

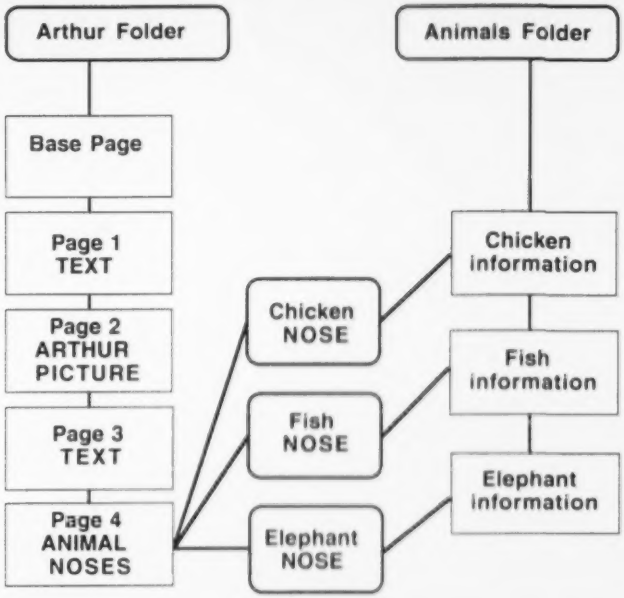
A wonderful fact about a hypermedia presentation is that the focus doesn't have to be on the end-product. A LinkWay folder, once begun, can virtually take on a life of its own. For example, a social studies teacher may start out creating a folder on Europe. Next, the teacher may develop a folder on Yugoslavia, linking it to the original Europe folder. Next time around, she may have small groups of students work together, each creating a folder about a different country in Europe. These can all link to a central menu folder about Europe. These folders can be extended or reorganized individually.

Hypermedia LinkWay folders have been created by students and their teachers on topics such as the solar system, artists, history, and creative writing. A first grader created a folder called *Andrew's Animals* for which he researched animals that live in various locales (McMillan, 1990). With help from his teacher he added digitized images of animals using a scanner, wrote brief text about each, and created a menu screen with choices for learning about different types of animals. Likewise, high school students have created hypermedia folders that include not only text and graphics but also animation to more effectively illustrate a concept.

Application to Special Education

LinkWay folders are easily used by learners with special needs because of the ease of use of the "point and click" navigation style for both using and creating the hypermedia documents. Graphic symbols can be used for students who would have difficulty reading instructions in text form. For users with physical disabilities, adjustments for text and graphic size and sensitivity to movement of input devices such as the mouse can be made. Some commercial educational products use picture icons along with significant amounts of visual and audio feedback.

Figure 1



The flowchart shows hypermeida enhancements added to the children's story,* Arthur's Nose *(Brown, 1982).

One of the most significant and powerful contributions that software like LinkWay offers special education is its value as a creativity tool for students. Using LinkWay or another hypermedia authoring system, a child becomes an active partner with the computer in a creative, organizational process regardless of how simple or complex the material.

The critical thinking skills required to organize a folder presents a motivating challenge to students. Enabling students with special needs to participate in the creation process places new cognitive demands on them while keeping the challenge within a content area or language level that is appropriate. Learners can take material with which they are familiar and approach it in a new way as they manipulate and organize it for a folder.

The critical thinking and organizational aspects of the folder-making process can be modeled by using a concept map or a flowchart, techniques that visually and graphically represent the structure of information. Figure 1 illustrates a flowchart for a simple story based on the book, *Arthur's Nose* (Brown, 1982). Arthur is an aardvark, and in this story, Arthur decides to change his nose. The boxes on the left of the flowchart represent the screens of the linear story line. On Page 4, Arthur goes to a nose doctor to try some different noses, each of which is drawn on the screen and linked to a folder about the animal whose nose Arthur is considering. The reader can learn more about each animal and help Arthur decide which nose to choose by accessing the hypermedia enhancements added to *Arthur's Nose*. The flowchart visually depicts the relationships between folders and pages in this simple but engaging hypermedia adaptation of a children's story.

The topic for a folder can be as simple as matching shapes and colors or as complex as simulating a science experiment. Youngsters who have difficulty with reading can create stories without words by drawing simple pictures using the "paint" tools. Older children may enjoy creating "choose-your-own-ending" stories.

Within a mainstreamed classroom environment, working on folders offers significant opportunity for cooperative learning. Groups of students, including those with special needs, can plan and implement projects with each student having individual responsibilities suited to individual capabilities. The planning and organization of the folder can be modeled by those who take over leadership roles. Once the basic organization is decided upon, then planning for what goes on each page begins and assingments are made. The thinking aloud, planning together, and organizing who will do which assignments is a vital part of the learning process even if the resulting presentation is only a few pages.

Some ideas for hypermedia projects include a computerized yearbook in which a class photo is used as a graphic menu for accessing information about students. Each face in the photo is linked to more information about that particular student. Another idea has resource room students learning LinkWay or another authoring system away from the mainstreamed classroom. They are then used as peer tutors when the software is introduced into the regular classroom, thus giving these students the opportunity to be experts.

The LinkWay software can produce hypertext and hypermedia documents with a computer only, or include connection to and

control of multimedia devices such as CD-ROM and videodisc players. It is an exciting hypermedia and multimedia tool for the IBM PC and compatible computers, offering many possibilities for new learning opportunities for students in special education classes.

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A Principal's View of Hypermedia

By Vera Risdon

The job of a principal is exciting, intense, anxiety-producing, but vastly rewarding. Over the past three years, one of my most exciting and rewarding experiences has been to observe the influence of a hypermedia computer assisted instruction (CAI) project on the teachers and the students in the classrooms of my elementary school.

When the project was first presented as a possibility to a group of principals in 1988, I knew nearly nothing about hypermedia and nothing at all about the application suggested for development. What I did hold as a firm conviction, however, was the concept of a future in education enormously influenced and made more effective by computer technology and associated developments.

I became a convert to this concept while teaching a classroom of gifted fourth, fifth and sixth graders when, in 1981, a far-sighted parent donated an 8K Atari to our classroom. The potential for the computer as a tool to empower students and facilitate control of their own learning was clearly demonstrated even with that early equipment. I well remember a very bright young man discovering, with the most basic of programming skills, that he had written a program to produce the powers of two. His having written the program was not memorable; what I do remember so vividly is his sense of accomplishment and discovery.

In the years since, I have seen that phenomenon repeated time and time again. In a recent issue of Teacher (January, 1991) devoted to teaching with technology, Jeff Meade commented about teacher commitment which has resulted from such experiences. He called these computer-using teacher "pioneers" who have embraced technology because they believe it can extend their reach, empower their students with imagination, and encourage curiosity and creativity.

Another recent publication reporting on the effectiveness of microcomputers in schools further documents my personal observations and conclusions. In a fascinating review of research conducted

Author Profile

Vera Risdon, principal of Hazelwood Elementary School, is a Washington state native. Ms. Risdon completed her undergraduate work at Washington State University and received a Masters Degree from the University of Washington. She taught intermediate grades for 16 years before becoming an elementary school principal. Ms. Risdon was recognized as the Outstanding District Administrative Support Employee in 1991 by the Renton, Washington, school district. For more information, contact: Vera Risdon, Hazelwood Elementary School, 6928 116th Ave. S.E., Renton, WA 98056.

from 1986 to 1990, published by the Software Publishers Association, Bialo and Sivin (1990) reported that the empirical research base for using computers in schools confirmed that technology could make an important difference when used appropriately as a learning tool.

Prior to implementation of the hypermedia study, teachers at my school of approximately 550 students, had acquired several Commodore computers through a generous PTA and eleven Apple IIe's through the school district. During the final year of the hypermedia study, ten Macintosh SE's were added to the eight already in place in the school. Early emphasis in my school district, as in many, had been on "computer literacy." During recent years, however, the focus had shifted to use of computers as tools integrated within the curriculum, and slow but steady progress was being made in that direction.

With these limited resources, teachers who were to be involved in the project varied widely in their degree of experience with computers, but all had had enough exposure to be intrigued with the potential of the hypermedia project when it was presented for their consideration. One hundred percent of those eligible to participate agreed enthusiastically, and their enthusiasm only grew as the three-

year project continued. Two important elements which contributed greatly to early teacher comfort with the project were: (a) use of regular curricular materials enhanced through hypermedia as the content base and (b) use of regular instructional strategies along with the computer lessons. There was a real sense of success from the outset. Students quickly mastered the skills needed to access the computerized lessons and engaged eagerly in the reading activities presented. Students were then observed to apply skills presented in computer lessons in other settings. Staff members awaited the periodic data analysis with great interest. Our intuitive feeling was that students, particularly those for whom acquiring reading skills was difficult, were benefitting by the use of hypermedia, and we were pleased to find our feelings validated by the results of that analysis.

Certainly the students' enthusiasm and engagement were plain to see. I have keen memories of children engrossed in their work at the computer and of their pleasure and skill in explaining their activities to me. At the completion of the study, one second grade class prepared a book of thanks for the researchers which confirmed my feelings and observations. Every student contributed a page with picture and text, and I was amazed and pleased by their memory for the detail of the lesson format and by their enthusiasm for what and how they had learned. These children had faithfully recreated everything! All the command icons, the mouse, the highlighted text — every detail was there.

Their comments further verified their knowledge and interest. I was particularly impressed with the students' response to the "comprehension" questions. As anyone knows who has tried to teach comprehension by having students reread material and then express their comprehension verbally or in writing, some students have great difficulty with this task and resist doing it. Using hypermedia, it became some students' favorite activity because they could respond by "clicking" on the answer; the laborious response needed before was eliminated. Not only that, if they had trouble finding the answer, the program design further limited the text they needed to search. Finally, there was an immediate and positive reinforcement as they were successful, and their success in this setting generalized to the testing conducted. Other lesson elements, including being able to hear the word spoken and being able to work at their own pace received similar accolades from the children. Perhaps as much as any data analysis could provide, their book attested to the present and future value of this and similar strategies.

Teachers, too, have benefitted by this step into the future. They

have in their hands the tools to duplicate the hypermedia project using whatever source materials they might choose. In addition, some have already branched out into other hypermedia, such as CD ROM encyclopedia projects and multimedia production with their students, incorporating the cooperative learning strategies so important to the staff here at my school. They, and I, are more convinced than ever that the best is yet to come.

We know the workplace and the world are changing swiftly and we accept that schools must restructure to better prepare students for the challenges they will meet in a future which we cannot adequately imagine. Technology holds out hope for facilitating such growth. Judith Billings, Washington State Superintendent of Public Instruction, recently wrote in the 1990 Educational Technology and Telecommunications Survey conducted in Washington State (February, 1991)of the 1990s as a "gateway decade" with technology as the catalyst for accelerating change in political, social, environmental, economic and cultural arenas. Similarly, John Kearnan, CEO of Jostens Learning Corporation, was quoted in Agenda (Mageau, 1991) regarding the power of technology as a catalyst for broad reforms. He reported that many progressive school districts were using technology programs to "jump-start much bigger reform activities" such as teacher empowerment and new approaches to instruction.

Hypermedia represents one of those significant opportunities for growth and change, creating the chance for educators to be co-explorers with their students in promoting high standards of student performance and the development of cooperative work skills and enthusiasm. Principals across our nation will be privileged to help facilitate such change.

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The Multimedia Classroom

By Elaine Montoya Prickett

Multimedia provides multi-dimensional learning experiences to help students go beyond the walls of the classroom, taking their learning in multiple directions rather than following a linear path. Multimedia helps those students who have difficulty learning in traditional ways tap into their strengths so they can find ways to communicate and represent the knowledge and understanding they have of their world. It also helps students find new ways of applying knowledge to solve problems. We need to prepare our students to be problem solvers, because they will have to function in a world filled with problems that we cannot even imagine today.

Multimedia allows students to manipulate and interact with information in ways that traditional tools do not allow. They learn to analyze, synthesize, and solve problems with information that they have taken control of as active learners. Multimedia tools are flexible, allowing teachers to integrate them into the classroom. As tools, they should be used in all areas and not formed into a single content area. This article will provide some guidelines for using multimedia as a tool in the classroom, and will describe some practical applications of multimedia that have been used with first and second grade students.

I have had considerable experience with the Apple II series computers and somewhat less experience on the Macintosh. This experience ranges from using a single Apple II with open-ended software (e.g. word processors, databases, and desktop publishing), to state-of-the-art multimedia equipment that students used manipulate vast amounts of information from several different media.

My students, however, had very little experience using computers. They came from low socio-economic households and none of them had computers at home. My classroom had a high number of "at risk" children with a lot of special needs. Many of these children were Chapter 1 programs or were in special education classes. These were children who often not successful in classrooms using traditional teaching tools and methods.

The state-of-the-art equipment we used was part of the Albuquerque Public Schools Multimedia Project, a traveling multimedia

Author Profile

Elaine Montoya Prickett, M.A., teaches second grade at Kit Carson Elementary School in the Albuquerque Public Schools (APS). Elaine has participated in the APS Multimedia Project for the past two years, integrating computer technologies in all facets of classroom instruction. Special education students are often integrated into her regular education classroom, and she has found technology to be an effective means to meet their needs. Elaine is currently a Danforth fellow and is completing her Educational Specialist Degree in Educational Administration at the University of New Mexico. For more information, contact: Elaine Montoya Prickett, Kit Carson Elementary School, 1920 Byron Road S.W., Albuquerque, NM 87109.

lab that consisted of a Macintosh IIx computer, a CD-ROM drive, two Apple //GS computers, an EPS Sampler (a keyboard), a Laserwriter IINT printer, an Imagewriter II printer, an Apple Scanner, a videodisc player, and VHS camcorder.

Software for the lab included: HyperCard (Atkinson, 1987), assorted HyperCard stacks, SuperCard (Appleton, 1989), Videoworks II (Macromind, 1987), Fantavision (Anderson, 1985), Computer Eyes (Digital Vision, 1987), Pixelpaint (Harris & McGreggor, 1987), PaintWorks Plus (Zuzelo, 1986), Music Studio (Forrester, Parfitt, & Wickman, 1988), VCR Companion (Elliott & Ewens, 1988), Children's Writing and Publishing Center (Joers & Stone, 1988), SuperPrint (Grey & Humphrey, 1987), Slide Shop (Brackett, 1988), Nova Pathfinders Laserdisk and software (NOVA, 1990), and BioSci Videodisc (Lippke & Johnson, 1990).

In order to use the lab in my classroom I had to write a proposal specifying how it would be used. I was awarded the lab for a period of two months. Part of the requirement for having the lab was attendance at two summer classes in which we learned how to use much of the equipment and software. My experience using this multimedia lab in my classroom provides the foundation for the

following guidelines that may help other teachers integrate multimedia as a tool into their own classrooms.

Getting Started

The first day of the multimedia project, I told the class that there was lots of equipment and software in the room, and that I did not know how to use much of it. I told them that I could not help everyone all of the time, so they would have to figure out much of it on their own. I then proceeded to let them play with and discover all of the equipment and software. They were provided time to "find out what happens if" a certain button is pushed, or what a program looks like or what it can do. Children need to have opportunities to just play with the equipment and software for one to two weeks. Computer equipment is interesting to look at, and has lots of buttons and gadgets and sounds that intrigue children. They need to have time to satisfy their curiosities about the tools they are using.

Discovery Learning of Software

One of the most valuable problem-solving activities for students in my classroom is learning a new piece of software. It is important to give children the opportunity to learn how to use the software without direct instruction from the teacher. If the teacher always learns the program first and then teaches how to use it, the children are deprived the opportunity of going through a problem solving process themselves. When we receive a new software program, I give it to the children and ask them to learn how to use it. They in turn teach me how to use it. Not only does this provide opportunities for learning, but it also saves me time because I do not have to master every new program before it is incorporated as a classroom resource. This also provides opportunities for the students to take responsibility for their learning, which is important if we want them to be life-long learners.

Modeling a Problem Solving Process

The problem solving process should be modeled for children. There have been many times that I only partially understood how to use a software program when I began to show it to the class, only to get stuck part way through because I did not know what to do next. When this happened, I pulled out the manual and we went through it together, trying to solve the problem as a group. If it seemed that it would take some time to come up with the solution, then many

times some of the students would go on to other activities while a few stayed to solve the problem. The rest of the class would return at a later time and we would share what we had learned. If we want our students to be learners, then we need to show them that we are still learners.

In my classroom, I show the class some basics about a particular program or piece of hardware but do not teach all the specifics. Children will learn how to use the technology as their need arises. For example, one child discovered on her own how to "cut and paste" in a paint program. Before the week ended, more than half of the class knew how to do this, and everyone knew who to ask if they were not sure how to do it. This entire process occurred without any teacher instruction.

Setting Up the Environment for Group Process

The physical environment is crucial in a child-oriented classroom that uses technology as tools to the learning process. Within my classroom I use themes as a focus for learning, and utilize committees and cooperative learning groups as a means for students to work through the learning process. In order for these group processes to be effective, the environment needs to be set up in a way that is conducive to group process. The room is set up in areas with tables and the students have access to technology and other resources from any area in the room. If all of the technology is set up in one corner or area of the room, there will tend to be a "swarm effect" as many students gravitate toward that area. With technology dispersed about the room, the different groups utilize it more effectively without getting in each others way. This also makes better use of space and materials in the classroom.

Committees

Committees are groups of students that work in some type of activity as a team. Each group rotates through all activities so that they have an opportunity to be involved in each of the learning experiences. The committees tend to have more teacher direction, which is often essential when students are first learning to work through the group process.

Cooperative Learning Groups

Cooperative learning groups tend to be student directed. Many times one group will work toward solving a single problem over a period of time. Not all groups will be involved with all activities, but each group works on one piece of a larger class project. In the end, each group puts in its piece to create the final project. For example, the students chose to create a videotape to represent what they had learned. The class as a whole brainstormed and decided to use a news format for their video. They then determined what would need to be done in order to accomplish this task, and *they* decided on the separate groups (e.g., scripts, set and props, credits, music, animation, costumes) they would need to produce the final product.

A group of students was asked to set up a learning activity for the rest of the class. They were given the task of preparing an interactive HyperCard activity in which students would use the Macintosh and BioSci Laserdisc to view pictures of animals that live around the Rio Grande River, classify the animals, and describe the animals. The group responsible for setting up the activity had the task of (a) finding out what animals live around the Rio Grande through books available in the room, (b) locating pictures of the animals on the BioSci Laserdisc using the laserdisc manual, and (c) creating HyperCard buttons that would activate the Laserdisc to show the chosen animals. They also had to ensure that animals from all classes of the animal kingdom were represented.

The group that created the lesson included a student with a learning disability and communication disorder, and a student from the Chapter 1 program who had been retained the previous year. These students, especially, were very proud of their work. Throughout the week, while the other groups worked through the activity created by this group, these two students repeatedly made their way by the area to let the others know they had helped create it. This gave an extra dimension of excitement for the other groups, knowing that the materials had been created by their peers. Many times in special education there is a tendency to use drill and practice instructional techniques rather than to provide new opportunities and alternatives for learning. The technology tools in the multimedia lab provided alternate ways for my students to acquire and represent their knowledge. It was used along with many other, more traditional resources available in the room.

More Activities

What else did students do with multimedia? They researched plants and animals, put the information into a HyperCard stack, scanned pictures of the plant or animal to create a graphic for the stack, and linked related plants and animals using HyperCard buttons. They demonstrated the effect of oil in water on feathers and the effect of acid on water plants. They visited the Rio Grande Nature Center with a Camcorder and incorporated videotape of their visit into their news video about the river. They digitized pictures of their faces, imported the pictures into Paintworks Plus, and camouflaged their faces as a plants or animals from the riparian area (see Figures 1 & 2). They created a relief map of the river as it runs through New Mexico (yes, crayons, glue, paper, and old rags are still media). They published a newsletter using Children's Writing and Publishing Center informing parents and other students about the effects that humans have on the river environment. They wrote stories about a fictional battle between a leaf and the wind. They created an electronic ABC book using SuperCard and Pixelpaint, complete with digitized voices in Spanish. Technology allowed the students to experience integration of all the curriculum areas, thus enabling them to experience the curriculum as a whole rather than as separate entities.

Student Reactions

Students started to understand the importance of their learning and the importance of being able to articulate their thoughts and knowledge. For example, I had the opportunity to take a few students to the New Mexico Capitol during a legislative session, to demonstrate how they had incorporated technology into their learning. On the way to Santa Fe on the bus, one of the students looked up at me and said "It's important what we say to people and how we say it, and we need to be sure that they understand what we did and what we learned." This second grader was basically telling me that he needed to be articulate, that he understood the importance of our trip to Santa Fe, and that it might effect our school.

The students had other opportunities to communicate what they had learned, and felt good about themselves when they did this. One time, when the principal came into the classroom, a group of students were telling him about the "riparian area" while they showed him pictures about the area from a laserdisc. He first had to stop them to ask what "riparian" meant, as well as ask them how the laserdisc

Figure 1

I eat cheese but I'm not a baby.
I'm little but you can see me.
I might be gray or brown or black.
I can't fly but can walk.
I have big ears but I'm not a rabbit.
What am I?

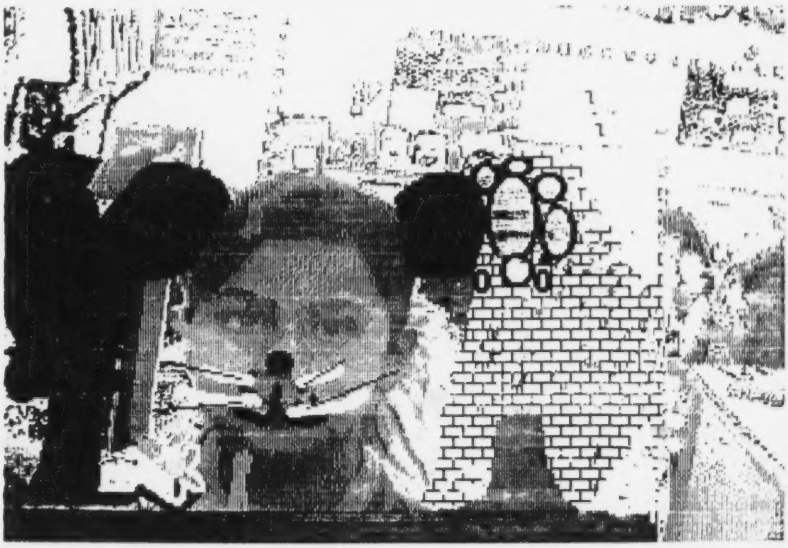
Virginia

Students wrote a riddle about the animal they chose.

worked. He was not just being a good questioner, but did not know the answers and was truly seeking information from these second graders. They beamed with excitement at the thought that they had knowledge of something that they could offer to someone else, especially the principal of their school. These were students who in the past had often been thought of as the "slow ones" who never got their work done and rarely had anything to offer other students. They were the ones who were always seeking help and now they were giving it.

The technology also helped the students become aware of and practice using skills that will help them to solve real life problems that plague our society today. One day Aaron was working with a group on a simulation that dealt with sea turtles that were becoming extinct.

Figure 2



Graphics can easily be personalized with pictures of the students by scanning a photograph or digitizing directly from a videotape image.

The simulation provided interactive video segments as students solved some of the problems involved with the turtles becoming extinct. In one segment the students click on a turtle nest and the baby turtles are supposed to run out of the nest into the sea. I will never forget the concern on Aaron's face when he ran across the room to tell me that the baby turtles were going the wrong way and his group did not know why. I suggested that they look and see what the turtles were running toward. On further investigation, they discovered that the lights from a condominium complex were confusing the turtles. Aaron came back across the room with relief on his face to tell me how he had solved the problem. This was a child who was concerned and involved in trying to save the turtles. He would not have had this opportunity and experience by reading it in a book. Being directly involved in the situation made it more personal.

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Teacher Reactions and Observations

There is a tendency for some teachers not to allow children to handle all of the equipment for fear that it might get damaged. I found it important to give students ownership of the equipment. When it became theirs, they took better care of it and watched to be sure that others took care of it also. I have had many opportunities to visit other schools to see how their technology is being used, and have found that teachers who do not give this ownership to students tend to have more trouble with equipment being damaged.

The first year that I used the multimedia lab in my classroom, it was just me and 23 second graders. I had no other adults helping me with the planning or implementation of the activities. Many times this was difficult because on days that seemed like total "flops" I had no one with whom to hash out the problems and come up with new ideas. Also there was a lot of planning time involved, and I had to do this all on my own. The second year I did some team teaching with another teacher in the school. This made things a lot easier because we could feed off each others ideas. Also, the preparation time was cut in half and two adults were present in the room to take care of problems.

Trial and Error

Up to this point, this paper has created a picture in which nothing went wrong. This is far from the case. There were many days that seemed total disasters, and that learning did not take place. This happened often in the beginning when we were first getting started. I realize now that those failures were part of the process and as such were not failures at all, but part of the learning process that had to take place. This was never more evident than when, in the second year, my partner felt that it was not working and that her kindergarten students were not learning. Having been through it before, I assured her that it would work and that we needed to give it time. She was finally convinced and a week later told me that she was glad that we had not given up too soon.

During the time that we used the multimedia technology there was a tremendous sense of excitement in the classroom. It was full of students during recess and I often had to tell students to leave the room at the end of the day. There was increased self esteem in my students as well as an increased ability to solve problems. They seemed to become more flexible in their thinking, seeing interrela-

tionships and connections in ways that they had not done before. I think that this was in part due to the technology that they were using, because it shows that there are complex interrelationships that are not easily discovered using linear tools and segregated curriculum areas. Another important outcome was that nobody failed. Since there are so many options when using technology, everyone can find a way to succeed. Educators will need to change their paradigms of instruction, realizing that a pencil is not the only tool for representing what has been learned. I think that Brian summed it all up in one statement when he was asked why it was important to use the computer. He answered with a furrowed brow and a thoughtful look, "Some people just can't use a pencil well."

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Hypermedia Enhanced Basal Readers: "A book can't do that..."

By Randall Boone and Kyle Higgins

"Well, maybe if you're reading and you come to a word that you don't know. And if it's black and underlined...then you could click on it and it would say the word for you. A book can't do that."

Nine-year-old Matt gives his reason for preferring to read from a hypermedia lesson than from his basal reader textbook. Matt is in third grade and has used hypermedia reading lessons as a supplement to basal reader instruction every year since he was in first grade. The computer hardware and the hypermedia software convention of non-linear, instantaneous access to additional information through pop-up windows for text and graphics, computer-generated sound and speech, syntactic and semantic clues along with other compre-

Author Profile

Randall Boone is an assistant professor of educational computing at the University of Nevada, Las Vegas. Dr. Boone's main interests are in educational multimedia and hypermedia systems and educational computer use with emphasis in reading, writing, and language arts. His current work concentrates on adapting content material to hypermedia and multimedia formats. For more information, contact: Randall Boone, University of Nevada, Las Vegas, College of Education, Dept. of Curriculum and Instructional Studies, 4505 Maryland Parkway, Las Vegas, NV 89154.

hension strategies are all part of Matt's reading and learning background.

Matt was a participant in a three-year-long, school-based, cooperative research project between the University of Washington and his elementary school to investigate the educational possibilities for hypermedia instructional materials in elementary school. Students in kindergarten, first, second, and third grades at Matt's school used hypermedia reading software developed specifically for the project and based on the stories from their basal readers as a supplement to their teachers' instruction. Students were selected randomly each year for experimental and control classrooms resulting in students receiving differing amounts of hypermedia reading experience during the three years of the project. Matt was among about 15% of the students who were selected for the experimental classroom each year.

The hypermedia lessons consisted of verbatim text from the basal reader stories set on nonscrolling screens that were linked linearly from first to last with the option of paging forward or backward and with first and last pages linked to provide a circular paging format. The interface between student and computer was kept constant from lesson to lesson and book to book through visual iconic representa-

Author Profile

Kyle Higgins is assistant professor of special education at the University of Nevada, Las Vegas. Dr. Higgins' specialties are in the field of learning disabilities and computer applications for students with learning handicaps. Her current research interests include the adaptation of content material to the hypermedia format as well as the use of hypermedia and multimedia in the education of students from diverse cultural backgrounds. For more information, contact: Kyle Higgins, University of Nevada, Las Vegas, College of Education, Dept. of Special Education, 4505 Maryland Parkway, Las Vegas, NV 89154.

tions of commands for controlling the lessons, as well as verbal instructions and other auditory cues and reinforcements relayed to students via headphones.

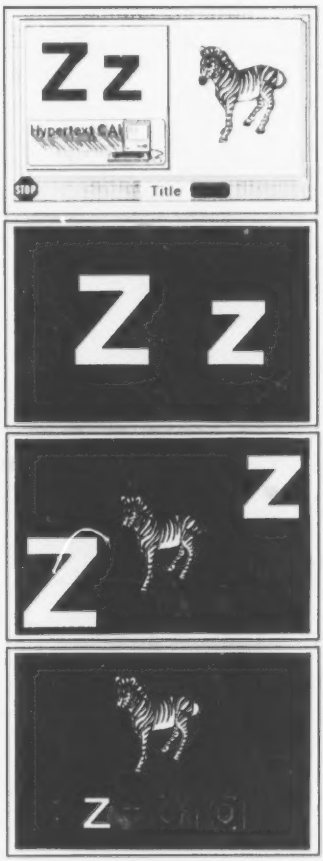
Kindergarten lessons focussed on letter identification, letter names, and the initial sounds of letters in words (see Figures 1 and 2). Letter names and words that start with the letter were spoken for students along with all directions and reinforcement. Lessons at the first, second, and third grade levels included enhancements to the basal vocabulary words, instructional enhancements for understanding the syntactic and semantic elements of pronoun / antecedent pairs and other anaphora, and comprehension strategies constructed in an educational scaffold format to provide students with as much or as little help as they required (see Figure 3).

Approximately 50% of the stories from the basal reader series, preprimer through fourth grade, were adapted as hypermedia lessons. Students used the lessons independently either before or after a teacher-directed reading activity, rotating from independent seat work at their desks to the computer stations in their classroom. Each teacher developed her own classroom management plan for integrating the computer-based hypermedia lessons into the regular reading program. The management plans ranged from elaborate schedules posted in the reading center to simply having students be responsible for each other and notifying the person who followed them on the computer.

Empirical evidence from this study, based on pre- and posttest scores from criterion-referenced achievement tests between experimental and control classroom situations and across grade levels, supports the use of hypermedia computer-based reading materials especially for students who are in the low reading groups and generally having difficulty in reading instruction (Higgins and Boone, 1991). While the instructional design and purpose of the hypermedia software developed and used in this research must be credited when examining its educational effects, the hypermedia interface receives its due from evidence of students' and teachers' continued enthusiasm for working with the lessons. This combination of interesting media interface and solid pedagogy will make hypermedia an educational technology that cannot be ignored.

Teachers who used these multimedia / hypermedia enhanced texts in their classrooms during the three-year research project agreed that it gave them a flexible way of getting individualized attention to students without creating a lot of extra problems for themselves in

Figure 1



The initial page of the hypermedia lesson provides a tutorial based on the letter being introduced. Students are asked to "click on" the letter "Z" to begin the lesson.

The letter "Z" is shown in both upper and lower case forms and its letter name is pronounced. The dark background tells students that they should keep clicking the mouse button until a "white" page appears.

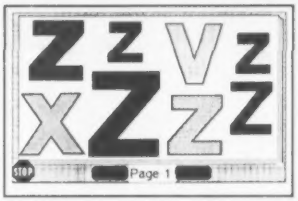
Here, the upper and lower case Zs move aside to make room for a picture of a tiger. The word "zebra" is spoken along with the letter name. "Zee....zebra."

Finally, the letters disappear and the word "zebra" appears below the picture. The word "zebra" is spoken again. The initial "white" title page appears next. Students may repeat this tutorial loop or go on the the next page.

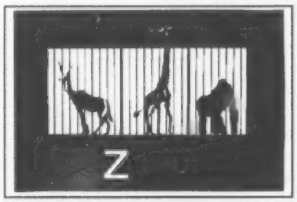
An opening sequence of hypermedia windows in a kindergarten lesson.

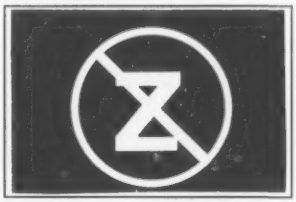
Figure 2

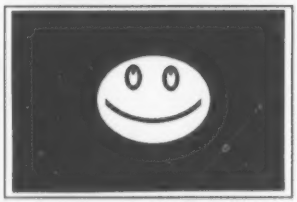
Students are asked to "click on" all the Zs on the page. A correct choice shows a picture of something that begins with the Z sound and the word is pronounced.



Students are told "That was not a Z." if they choose incorrectly.







An animated face speaks a word of encouragement when a correct choice is made.

A kindergarten lesson provides a tutorial on a particular letter, incorporating digitized speech, representative graphics, and animation in a student-centered hypermedia format.

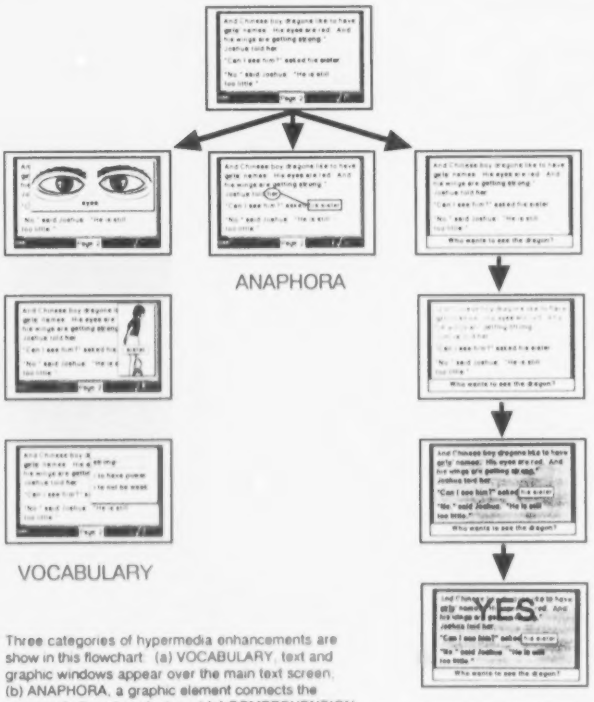
planning or classroom management. These impressions of ease of use and integration, however, may stem more from the instructional design and goals of this particular software than from any inherent quality of a multimedia / hypermedia system. Other designs may require more time and energy, but may in turn offer greater educational benefit.

Results of Teacher Questionaire

At the end of this three-year study the seven teachers (K-3) who had used the hypermedia reading lessons in their classrooms were

Figure 3

Flow chart showing hypermedia reading enhancements.



Three categories of hypermedia enhancements are show in this flowchart: (a) VOCABULARY, text and graphic windows appear over the main text screen; (b) ANAPHORA, a graphic element connects the pronoun to its antecedent; and (c) COMPREHENSION, students search for the line of text where the answer to a question is found. The software limits the text to be searched each time an incorrect choice is made.

A flowchart shows hypermedia reading enhancements.

asked to complete a likert-type questionaire concerning issues related to hypermedia. Teachers expressed their opinions by ranking fifteen statements about hypermedia use in education from *agree strongly* to *disagree strongly* (see Table 1).

The results indicate that the overall view of the teachers concerning the integration of hypermedia into their classrooms and the effect on student performance is positive. All teacher responses fell into the *agree strongly* and *agree* categories except for 17% of the teachers who were *neutral* concerning the statement *hypermedia can not replace the teacher*.

Some written comments by the teachers in the areas of *Academic Effects, Affective Effects, and Teacher Affect* are as follows:

Kindergarten

Academic Effects

"I felt the hypermedia software did improve the performance and knowledge of students who were in my low group."

"I liked the idea of a hypermedia program that enhanced what I was already doing in my classroom."

Affective Effects

"I feel that the use of the hypermedia software has given my students a positive feeling about the computer and their own ability to use the computer with little or no adult interference."

"I feel that my students gained academic knowledge, but as a first experience in school they also gained positive feelings about themselves as learners and about the computer as a learning tool to aid their learning."

Teacher Affect

"I was glad that the children did not have to use the keyboard—this can be very frustrating in kindergarten. Many children do not experience the same feeling of success while using the keyboard that they feel when using the mouse."

"I enjoyed being bombarded with questions about the hypermedia lessons and the computer."

Table 1

Experimental teachers' views on issues related to hypermedia

	agree strongly	agree	neutral	disagree	disagree strongly
helped students become better readers	83%	17%			
helped students in vocabulary development	67%	33%			
helped students in pronoun understanding	60%	40%			
helped students in comprehension	20%	80%			
teacher would continue hypermedia lessons	83%	17%			
hypermedia lessons were a good use of computer	100%				
all textbooks should have a hypermedia component	83%	17%			
integrating hypermedia was easy	67%	33%			
integrating computers was easy	83%	17%			
hypermedia is as effective as an aide	50%	50%			
would continue using hypermedia	40%	60%			
hypermedia can not replace the teacher	50%	33%	17%		
students did not tire of hypermedia lessons	67%	33%			
"novelty effect" not a factor in student interest	50%	50%			
hypermedia books are expected in the future	67%	33%			

The chart reveals teachers' positive attitudes toward well-integrated hypermeida reading materials.

1st grade

Academic Effects

"Kids in the low reading group really did better without as much work on my part."

"The use of hypermedia by children with different learning styles gave them more options to learn."

Affective Effects

"Students in the low reading group were more motivated and liked reading better. They felt better about themselves."

"The children were eager to learn to read in a new and innovative way... the children were proud of their accomplishments."

Teacher Affect

"I have always felt that computers are great if the software goes along with my curriculum."

"I have become a firm believer in the use of hypermedia and the computer in my reading program. In fact, I have become such an enthusiast that I have taken many courses to improve and enrich my teaching abilities."

"The parents were amazed, they couldn't believe that their children could do all that they were doing on the computer ... and then when they saw the reading gains that their children had made they were astounded!"

Second grade

Academic Effects

"The comprehension of my low reading group improved so that they were correct more often in answering oral comprehension questions during reading group. All of my students were on grade level by the end of the year when my class used the hypermedia lessons."

"The first year I had four students who were really struggling in reading. When they began to use the hypermedia lessons they seemed to be more focused in on the stories."

"I have found that many of the skills presented in the hypermedia lessons have generalized to other situations in my classroom."

Affective Effects

"My students appeared more enthusiastic in reading group."

"My students made more progress, they were excited to work on the hypermedia lessons, they were on task, and they were more tuned in to the reading task."

Teacher Affect

"I like the positive encouragement that the students get from working on the computer. I think that it is a fantastic tool."

"The use of the hypermedia lessons was not an extra program ... it was a supplement to my instruction. It was a freeing activity in that I didn't have to grade it."

"With more and more students from special education being mainstreamed into the regular classroom, the hypermedia reading lessons are handy tools to have."

Third grade

Academic Effects

"The application of hypermedia that I used for one year was like a tutor for my students, this was particularly beneficial for students in my low group."

"My slower readers seemed to gain more confidence and they functioned better in their reading groups."

Affective Effects

"An interesting aside was the willingness the program generated in my class being willing to help each other access the hypermedia lessons."

"The children all liked using the hypermedia lessons. It was a great tool."

"Many of my students have used the hypermedia reading lessons for three years and I haven't noticed any change in their enthusiasm. They still ask when is it their turn to read on the computer."

Teacher Affect

"While I am not as excited about computers as some other teachers, the use of hypermedia in my classroom helped me to see that the integration of technology into the curriculum is a thing of the future."

"This was a terrific way to integrate computers into the curriculum."

"The hypermedia reading lessons provided the students with a taste of what hopefully we will soon do routinely in education."

Student Comments

Students also had the opportunity to voice their opinions about the hypermedia reading lessons. Several of these students who wrote the following comments had hypermedia as a part of their reading instruction for three full years, either kindergarten through second grade or first grade through third.

The best thing about reading on the computer is.....

"You don't have to turn the pages."

"You get to answer questions and get page summaries."

"You don't have to write anything."

"It tells you what some of the words are."

"You can read a story and if you don't know a word you can click on it to find out."

"The computer cheers for you if you answer the question right."

"I like answering the questions."

"It asks questions about the story."

"When the word is in black type you know it will say the word for you."

"It has helped me learn to spell."

"You learn more."

"You can turn the pages as many times as you want."

"You get to hear hard words."

"It's an easy way to read."

"If you don't know a word, if you click on the word it tell you it."

"There were pictures."

"It tells you more about the story."

"It's fun!"

"It talks to you."

"I learn a lot!"

"It is fresh and totally rad!"

"It tells you the hard words."

"...seeing the pictures."

"If you don't know the underlined word you can click on it."

"That you get to click on dark words."

"I don't have to read with the other kids."

"You get to click on the words and hear them read to you."

The worst thing about reading on the computer is....

"I didn't get to use it for reading this year!"

"I can't do it at home."

"Sometimes I don't get all my work done."

"The mouse is hard for me to control."

"The worst thing about reading on the computer is nothing."

"Sometimes it takes too long."

"Nothing."

"You have to wear headphones."

"I didn't get enough time."

"You have a time limit."

"If you click on stop by mistake you have to start all over."

"When I have to do it at recess."

"When my time is up."

"Sometimes it doesn't tell you the hard words."

"It is not long enough."

"That they don't ask a question on every page."

"When you get an answer wrong."

"Sometimes I don't have enough time."

The hypermedia-enhanced textbook fits easily into a well established paradigm for teaching and learning with which most teachers and students are already comfortable. Integrating hypermedia / multimedia enhanced texts into a classroom may present fewer problems for both teacher and students than implementing computer software that requires a significant change in the classroom routine or overall environment. Adapting content that is already part of the curriculum provides a smooth point of departure for teachers who are interested in exploring the educational usefulness of hypermedia.

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Resources

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Glossary of Terms

Authoring system. A programming environment designed for producing specific types of software, usually requiring less computer programming expertise than if using a high-level language such as BASIC, Pascal, or C.

Background. The graphics and text that is shared by all cards in a HyperCard stack.

Buttons. Areas of the computer screen that when selected perform specific functions—sometimes referred to as "hot text." The real "workers" in a hypermedia document, buttons allow the user to access information not directly available through menus or direct commands.

Cards. One screen in HyperCard is one card from the stack. All cards in a stack are the same size. Each layer can contain buttons, text, and graphics.

Click. This term is a verb used to describe the process of pressing the mouse button while the cursor is over a particular area of the screen.

CD-ROM. An information storage medium using the same technology incorporated into compact disk music reproduction.

HyperCard. HyperCard is a hypermedia authoring system for the Macintosh available from Apple Computer. HyperCard includes its own programming language with full high-level computer language capabilities. Although using HyperCard requires programming skills for creation of sophisticated hypermedia documents, it is much easier and less time consuming than development of similar material in a more conventional programming language.

Hypertext. The term hypertext refers to computer-based texts that are read in a non-linear fashion and that are organized on multiple dimensions (Spiro and Jehng, 1990).

Hypermedia. Hypermedia (is) a hypertext document that includes graphics, digitized speech, music, or video segments (Boone and Higgins, 1991).

Hypertalk The programming language included in HyperCard.

Icons. Graphic messages or symbols often used in hypermedia applications for specific commands or functions.

Integrated media. The linkage of text, sound, video, graphics, and the computer in such a way that the user's access to these various media is non-linear and virtually instantaneous (Hasselbring, Goin, & Bransford, 1991).

Glossary of Terms continued

Links. Along with nodes, links are the most fundamental components in a hypertext/hypermedia document. Links are defined by the author of a hypertext document and are explicit in that they connect the anchor node with the destination node. Thus, when the user activates the anchor node, a process of following the link to the destination node is implemented.

Linkway. This product is IBM's multimedia authoring system. It incorporates the mouse-controlled format of the Macintosh into the operation of the IBM and compatible computers. Linkway relies on the use of icons for linking information in the text. These icons indicate that different types of additional information are available to the reader. A special speech adapter is necessary for adding computer speech capabilities to the hypermedia documents created with Linkway.

Liquid crystal display (LCD). Placed on an overhead projector, the LCD provides large screen projection of a computer screen without the bulk or expense of a large screen monitor or TV.

Mouse. A hand-held input device employed in many hypermedia / multimedia systems to control cursor movement on screen.

Multimedia. Educational interactive multimedia (is) non-sequential and non-linear presentation of text, graphics, animation, voice, music, movies, or motion video in a unified information-delivery system centered on a personal computer, that involves the student as an active participant and is applied in an educational setting for any number of instructional purposes (Center for Special Education Technology, 1991).

Nodes. A unit of information in a hypertext/hypermedia document. Nodes are connected to other nodes by links. There are typically two types of nodes in a document: (a) anchor node—the node from which more information is accessed and (b) destination node—the node that contains the extra information.

Scanner. Using a technology similar to a copy machine, the scanner creates a file of digital information readable by computer graphics programs. This picture file can then be saved on disk.

Stack. Based on a metaphor of cards linked together in a stack for quick access, this is the term given to an application developed with HyperCard.

Glossary of Terms continued

Ted Nelson. Nelson coined the term "hypertext" in 1965. He has been in the process of developing a hypertext/hypermedia system called Xanadu ever since. The basic concept behind the Xanadu system is that it will become a repository for everything that has ever been written.

Vannevar Bush (1890-1974). Considered to be the "grandfather" of hypertext, Bush was the science advisor to President Roosevelt during World War II. In 1945 he described the Memex (memory expander) System in an article in *Atlantic Monthly* entitled "As We May Think." This system was a mechanized private file and library.

Video digitizer. Connected to a videotape or videodisc player, a digitizer transforms the TV video signal into a computer readable digital file allowing a picture from the screen to be manipulated by a graphics program.

Videodisc. Sometimes called a laserdisc, this medium can display full-motion or still-frame video of a very high quality. It can be searched frame-by-frame using a remote control, a barcode reader, or a computer. A videodisc can contain approximately 54,000 frames.

Window. A mini-screen containing either text or graphics that overlays the main computer screen or another window.

Publishers of Hypermedia Software

Activision
P.O. Box 3048
Menlo Park, CA 94025-3047
415/329-7699

Adobe Systems, Inc.
1585 Charleston Road
P.O. Box 7900
Mountain View, CA 94039
415/961-4400

Aldus Corporation
411 First Avenue South
Seattle, WA 98104-2871
206/622-5500

Bright Star Technology, Inc.
14450 NE 29th Pl. Ste. 220
Bellevue, WA 98007
800/243-4200

Broderbund Software
17 Paul Drive
San Rafael, CA 94903-2101
800/521-6263

CE Software
P.O. Box 65580
West Des Moines, IA 50265
515/224-1995

Chariot Software Group
3659 India Street
Suite 100C
San Diego, CA 92103
800/CHARIOT

Claris Corporation
5201 Patrick Henry Drive
Box 58168
Santa Clara, CA 95052-8168
415/960-1500

ComputerWare
490 California Avenue
Palo Alto, CA 94306
415/496-1003

Data Disc
1430 Willamette, # 577
Eugene, OR 97401

Delta Point, Inc.
200 Heritage Harbor, Ste. G
Monterey, CA 93940
408/648-4000

EarthQuest
125 University Avenue
Palo Alto, CA 94301
415/321-5838

Educational Activities, Inc.
P.O. Box 392
Freeport, N.Y. 11520
800/645-3739

Farallon Computing
2000 Powell St.
Emeryville, CA 94608
415/596-9100

Friedman Computing & Publishing
2347 Pine Ter.
Sarasota, FL 34231-4433
813/924-3238

GAMCO Industries, Inc.
P.O. Box 310J5
Big Springs, TX
800/351-1404

Publishers of Hypermedia continued

Heizer Software
1941 Oak Park Blvd., Suite 30
P.O. Box 232019
Pleasant Hill, CA 94523
800/888-7667

Highlighted Data
6628 Midhill Pl.
Falls Church, VA 22043
703/533-1939

ICOM Simulations, Inc.
648 S. Wheeling Road
Wheeling, IL 60090
312/520-4440

Idea Form, Inc.
P.O. Box 1540
Fairfield, IA 52556
515/472-7256

Intellimation Library for the Macintosh
130 Cremon Drive
P.O. Box 1922
Santa Barbara, CA 93116-1922
800/3-INTELL

Koala Technologies
70 N. Second Street
San Jose, CA 95113
408/287-6278

Learning Services
P.O. Box 10636
Eugene, OR 97440-2636
800/877-9378

MacroMind
410 Townsend, Ste. 408
San Francisco, CA 94107
415/442-0200

MacWarehouse
P.O. Box 3013
Lakewood, N.J. 08701-3013
800/255-6227

MicroMaps Software, Inc.
P.O. Box 757
Lambertville, NJ 08530
609/397-1611

National Collegiate Software Clearinghouse (Software for the humanities and social sciences)
Duke University Press
6697 College Station
Durham, N.C. 27708
919/684-6837 ext.54

Nordic Software, Inc.
3939 North 48th St.
Lincoln, NE 68504
800/228-0417

Perseus Project
Department of the Classics
Harvard University
Cambridge, MA 02138

Print and Graphics Educational Systems
450 Taraval St. #235
San Francisco, CA 94116
415/665-3924

SmartBook
James Hardie Industries Limited
65 York Street
Sydney, NSW 2000
Australia

Publishers of Hypermedia continued

Silicon Beach Software
P.O. Box 261430
San Diego, CA 92126
619/695-6956

Software Excitement!
P.O. Box 3097
6475 Crater Lake Highway
Central Point, OR 97502
800/444-5457

Springboard Software, Inc.
7808 Creekridge Cir.
Minneapolis, MN 55435
800/654-6301

Ztek Co.
Interactive Videodiscs & CD-ROM for Education
P.O. Box 1055
Louisville, KY 40201-1055
502/584-8505

CD-ROM Publishers

Facts on File
460 Park Ave. South
New York, NY 10016
212/683-2244

Grolier Electronic Publishing, Inc.
95 Madison Ave.
New York, NY 10016
212/696-9750

Highlighted Data
P.O. Box 17229
Washington, D.C. 20041
703/241-1180

Optical Media International
485 Alberto Way
Los Gatos, CA 95032
408/395-4332

Quantum Access
1700 West Loop South
Ste. 1460
Houston, Texas 77027
713/622-3211

Wayzata Technology
P.O. Box 87
16221 Main Avenue
Prior Lake, MN 55372
800/735-7321

Xiphias
13464 Washington Blvd.
Marina del Rey, CA 90292
213/821-0074

Videodisc Publishers

Apple Programmers and Developers Association
290 SW 43rd St.
Renton, WA 98055
206/251-6548

American Folklife Center
Library of Congress
Washington, D.C. 20540
202/287-6590

CEL Educational Resources
515 Madison Ave.
New York, NY 10022
800/235-3339

Grolier Electronic Publishing, Inc.
95 Madison Ave.
New York, NY 10016
212/696-9750

Great Plains National ITV Library (GPN)
P.O. Box 80669
Lincoln, NE 68501
800/228-4630

Info-Disc Corp.
Four Professional Dr. Ste. 134
Gaithersburg, MD 20879
301/948-2300

Interactive Media Corp.
55River Rd.
Grand View, NY 10960
914/358-1899

LaserDisc Corp. of America
200 West Grand Ave.
Montvale, NJ 07645
800/526-0363

Minnesota Educational Computing Corp.
6160 Summit Drive North
Minneapolis, MN 55430
800/685-MECC

Media Learning Systems
120 West Colorado Blvd.
Pasadena, CA
818/449-0006

National Geographic Society
Education Services Box 88
Washington, D.C. 20036
800/368-2728

Optical Data Corp.
Box 97
Florham Park, NJ 07932
800/524-2481

Pioneer Communications of America
600 East Crescent Ave.
Upper Saddle River, NJ 07458
201/327-6400

Smithsonian Press
Hamden Station
P.O. Box 4866
Baltimore, MD 21211
202/357-3133

Videodiscovery, Inc.
P.O. Box 85878
Seattle, WA 98145-1878
800/54V-DISC

The Voyager Co.
1351 Pacific Coast Highway
Santa Monica, CA 90401
800/446-2001

Books, Directories, and Newsletters

Claris HyperCard Development Kit. Claris Corporation. Available from: Claris Corporation, 5201 Patrick Henry Drive, Box 58168, Santa Clara, CA 95052-8168; 415/960-1500

Cognition, Education, and Multimedia. Edited by Don Nix and Rand Spiro. Available from: Lawrence Erlbaum Associates, Publishers, 365 Broadway, Hillsdale, NJ 07642

Cooking with Hypertalk 2.0 by Dan Winkler and Scott Knaster. Available from: Bantam Books Publishers

Computer Applications in Reading, Third Edition, Book No. 785, by J.S. Blanchard. Available from: International Reading Association, 800 Barsdale Rd., P.O. Box 9139, Newark, DE 19714-8139

HyperAge: The Journal of HyperThinking. Available from: HyperAge Communication, Inc., 5793 Tyndall Ave., Riverside, NY 10471-2113; 212/601-2832

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HyperLink Magazine. Available from: Publishers Guild, Inc., P.O. Box 7723, Eugene, OR 97401; 503/484-5157

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Inside HyperCard. Available from: The Cobb Group, Inc., P.O. Box 35160, Louisville, KY 40232; 800/223-8720

Interactive Multimedia: Visions of Multimedia for Developers, Educators, and Information Providers. Edited by S. Ambron and K. Hooper. Available from: Microsoft Press, 16011 NE 36th Way, Box 97107, Redmond, WA 98073-9717

MIX Magazine. Available from: 6400 Hollis St. #12, Emeryville, CA 94608; 415/653-3307

Should Schools Use Videodiscs? Available from: National School Boards Association, 1680 Duke St., Alexandria, VA 22314; 703/838-6722

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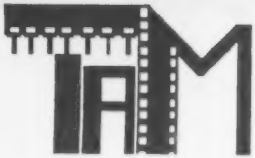

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